Study Report 98-04

Training Analysis and Feedback Aids (TAAF Aids) Study for Live Training Support

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July 1998

U.S. Army Research Institute
for the Behavioral and Social Sciences

A Directorate of the U.S. Total Army Personnel Command

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Director

Research accomplished under contract
for the Department of the Army

Advancia Corporation (formerly LB&M Associates)

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REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy) July 1998	2. REPORT TYPE Final	3. DATES COVERED (from... to) 10 February to 30 September 1997
4. TITLE AND SUBTITLE Training Analysis and Feedback Aids (TAAF Aids) Study for Live Training Support		5a. CONTRACT OR GRANT NUMBER DASW01-97-C-0022
		5b. PROGRAM ELEMENT NUMBER 65803
6. AUTHOR(S) Bill R. Brown, John W. Nordyke, Derick L. Gerlock, and Ira J. Begley II (Advancia Corporation, formerly LB&M Associates); Larry L. Meliza (ARI)		5c. PROJECT NUMBER D730
		5d. TASK NUMBER 2137
		5e. WORK UNIT NUMBER C01
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Advancia Corporation 211 SW "A" Avenue Lawton, OK 73501-4051		8. PERFORMING ORGANIZATION REPORT NUMBER 1163-5
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences ATTN:TAPC-ARI-IF 5001 Eisenhower Avenue Alexandria, VA 22333-5600		10. MONITOR ACRONYM ARI
		11. MONITOR REPORT NUMBER Study Report 98-04

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

COR: Larry L. Meliza

14. ABSTRACT *(Maximum 200 words)*:

Maneuver Combat Training Center (CTC) and home station requirements for exercise control and training feedback are intensive. With the advent of battlefield digitization; tactical decision aids ; "smart, intelligent, and brilliant" munitions; advances in non-lethal weapons, and new reconnaissance, surveillance, and target acquisition (RSTA) systems, the workload for trainers continues to spiral. Force modernization is creating new control and feedback tasks that have the potential to rob trainers of time they would otherwise spend observing, coaching, and facilitating the learning of exercise players. This study—

o Identifies the impact of force modernization on future exercise control and training feedback functions.

o Identifies tasks involved in after-action review (AAR) preparation, observer/controller (OC) coordination and mentoring , and take-home package construction.

o Provides strategies to reduce OC and Training Analysis Facility (TAF) workload .
o Identifies payoffs in task reduction achieved by each strategy.
o Does not provide technical solutions or an analysis of task criticality, complexity, duration, or frequency for trainer tasks.

15. SUBJECT TERMS

Tactical Engagement Simulation (TES)	Combat Training Centers	After Action Review (AAR)	Extrinsic Feedback
Digitization of the Battlefield	Collective Training Feedback	Home station training	Intrinsic Feedback

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON (Name and Telephone Number)
16. REPORT Unclassified	17. ABSTRACT Unclassified	18. THIS PAGE Unclassified	Unlimited	282	Larry L. Meliza (407) 384-3992

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July 1998

Army Project Number
20665803D730

Personnel and Training Analysis Activities

Approved for public release; distribution is unlimited.

FOREWORD

The ARI Simulator Systems Research Unit (SSRU) conducts research and development and performs studies on training requirements for advanced training systems, devices and simulators. SSRU provides assistance to the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM) and the U.S. Army Training and Doctrine Command (TRADOC) in test and evaluation activities, training requirements definition, development of device specifications, and evaluation of training equipment concepts. An important area addressed by the unit is the development of automated systems to support exercise control and feedback for collective training exercises.

The study described in this report was conducted in response to a request from the TRADOC Combat Training Support Directorate (CTSD) to estimate the effects of force modernization on the jobs of observer/controllers (OCs) and analysts in live force-on-force exercises at maneuver combat training centers and at home-stations. Force modernization under the Army's Force XXI program includes: new weapons systems; new reconnaissance, surveillance, and target acquisition (RSTA) systems; and digitization of the battlespace. This report describes how, in the absence of interventions, force modernization will increase the workload of trainers in the live force-on-force exercises and pull trainers out of the tactical information loop. The report also describes high level strategies for reducing workloads and helping to keep trainers informed of significant digital communications.

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Technical Director

TRAINING ANALYSIS AND FEEDBACK AIDS (TAAF AIDS) STUDY FOR LIVE TRAINING SUPPORT

EXECUTIVE SUMMARY

Requirement:

Maneuver Combat Training Center (CTC) and home-station requirements for exercise control and training feedback are intensive. With the advent of battlefield digitization; tactical decision aids; "smart, intelligent, and brilliant" munitions; advances in non-lethal weapons; and new reconnaissance, surveillance, and target acquisition (RSTA) systems, the workload for trainers continues to spiral. Force modernization is creating new control and feedback tasks that have the potential to rob trainers of time they would otherwise spend observing, coaching, and facilitating the learning of exercise players.

This report identifies the impact of force modernization on future exercise control and training feedback functions at the battalion (Bn) task force (TF) level and below during live training. The TAAF Aids Study identifies manual control and feedback tasks imposed by force modernization initiatives, after-action review (AAR) preparation, unit take-home package (THP) construction, and observer/controller (OC) coaching/mentoring.

Procedure:

Training facilities provide two types of feedback to exercise players: intrinsic feedback and extrinsic feedback. Intrinsic feedback is "downrange" feedback provided to exercise players during the exercise from actual and simulated entities and activities. When the tactical engagement simulation (TES) fails to provide intrinsic feedback based solely on rotating unit (BLUFOR) and opposing force (OPFOR) actions, OCs and Training Analysis Facility (TAF) analysts perform exercise control to provide player personnel the needed feedback. Extrinsic feedback is that feedback provided to BLUFOR in the form of AARs, coaching/mentoring, and THPs.

During the study we researched the Army Science and Technology Master Plan and Internet web sites to gain an understanding of the capabilities, operation, and employment of emerging systems. We identified the intrinsic and extrinsic feedback requirements for employment of these new systems in force-on-force training. We then contrasted these requirements against the capabilities of the current TES and instrumentation system (IS). Through this procedure we determined control and feedback tasks OCs and TAF analysts will manually perform in the

future if the TES and IS are not modified. To gain an understanding of control and feedback tasks OCs and TAF analysts currently perform, we visited two CTCs. We also reviewed exercise rules of engagement and OC handbooks. Considering current and future manual control and feedback tasks, we developed strategies to reduce OC and TAF analyst workload.

Findings:

As we analyzed the intrinsic and extrinsic feedback requirements imposed by force modernization initiatives, we identified 24 representative systems in which the analysis applied to 104 other systems (munitions, tactical systems, or technology demonstrations). The study also identifies 14 tactical systems which were special cases requiring a separate, unique analysis. The analysis supports a total of 142 systems/technology demonstrations.

Control and feedback requirements imposed by force modernization initiatives will overwhelm OCs and TAF analysts without a corresponding upgrade to the TES and IS. We developed 13 strategies to reduce the burden on OCs and TAF analysts. Of the 380 OC and TAF analyst control and feedback tasks identified by the study, implementation of all strategies will result in full to partial workload reduction for 368 tasks (97 percent). Further study is required to determine the criticality, complexity, duration, and frequency of each task and the workload reduction required to permit OCs and TAF analysts to perform their intrinsic and extrinsic feedback functions effectively.

Utilization of Findings:

The study describes the heavy workload imposed on OC and TAF analysts to support control and feedback requirements for existing and future weapon, RSTA, and communication systems in force-on-force training exercises. The study also describes concepts to reduce OC and TAF workload but does not offer technical solutions. Study findings provide input for future technical and behavioral research aimed at improving the effectiveness and efficiency of training at the Army's maneuver CTCs and home-stations. The findings will also support formulation of high fidelity requirements for future CTC and home-station IS and TES systems.

TRAINING ANALYSIS AND FEEDBACK AIDS (TAAF AIDS) STUDY FOR LIVE TRAINING SUPPORT

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TRAINING ANALYSIS AND FEEDBACK AIDS (TAAF AIDS) STUDY FOR LIVE TRAINING SUPPORT

Introduction

The TAAF Aids Study is a US Army Training and Doctrine Command (TRADOC) requested study under the technical supervision of the Army Research Institute (ARI) Simulator Systems Research Unit. The genesis of the study is the TRADOC Report on Live Domain Research Requirements prepared by the Combat Training Support Directorate (CTSD). The report states that force modernization initiatives in the Army Science and Technology Master Plan "will make current training support systems obsolete." The report predicts a spiraling workload for trainers and a degradation in combat readiness if action is not taken to upgrade support for live training. The report lays out a high level research plan for live training to resolve projected deficiencies (Faber, 1996a).

Unless stated otherwise, whenever this report uses the masculine or feminine gender, both are intended. See Appendix A for a list of abbreviations and acronyms used in this report. Before we discuss the purpose and scope of the study, we will define some terms we use extensively throughout the study.

Observer/Controller (OC)

The OC is a tactically and technically competent officer or non-commissioned officer who serves as trainer, observer, and exercise controller. He monitors safety, enforces rules of engagement, assesses casualties and battle damage, observes critical tactical events; performs one-on-one coaching, conducts after action reviews (AARs), and submits input to the training unit's take home package (THP). OCs at the Army's maneuver Combat Training Centers (CTCs) perform OC duties on a full-time basis. Occasionally, personnel from tactical units, TRADOC schools, and Reserve Component advisors perform OC duties to augment CTC OCs. At home-station installations, tactical units appoint personnel who are not participating in the exercise (non-players) to perform OC duties for the training unit.

Training Analysis Facility (TAF) Analyst

At the CTCs, a TAF equipped with computer workstations supports analysts who use a top-down view of the exercise, video, and player tactical voice communications to observe and analyze unit performance. The TAF analyst may be an officer, non-commissioned officer, Department of the Army civilian, or contracted civilian. Each TAF analyst is paired with a counterpart OC (i.e., a company team [Co Tm] analyst paired with a Co Tm OC). Working as a team, the OC and TAF analyst control the exercise, exchange observations on player activity, and identify the causes and effects that led to battle outcome. Before, during, and after the exercise the TAF analyst prepares AAR products to support the OC's AAR presentation. The primary focus of AAR preparations is on the Battalion (Bn) Task Force (TF) AAR. The analyst also integrates OC input and produces the THP for the training/rotating unit.

Tactical Engagement Simulation (TES)

The TES is a system which simulates the employment of a combat system during force-on-force training between a live training unit (BLUFOR) and a live opposing force (OPFOR). For example, to simulate direct fire engagements, weapons are equipped with a TES called the Multiple Integrated Laser Engagement System (MILES). MILES emits an eye-safe laser when the soldier fires the weapon. MILES sensors on soldiers and equipment detect engagement by the laser and produce an audio and/or visual signal for a kill, hit, or near-miss.

Instrumentation System (IS)

The IS is an electronic data collector that monitors position location and the TES devices on soldiers and vehicles and captures the activity of each player entity. The IS feeds the TAF with data that the TAF workstations convert into computer-generated graphics providing a top-down view of player location, status (alive or dead), movement, firing activity, etc. The IS also records player tactical voice communications, supports OC and TAF control communications, and displays video from mobile video crews in the exercise area.

Purpose

The purpose of the study is to:

(1) Determine the impact of force modernization on OC and TAF analyst exercise control and training feedback tasks during live training for systems in the following categories:

- Command, control, communications, computers, and intelligence (C4I) systems and tactical decision aids

- Weapon systems and "smart, intelligent, and brilliant" munitions

- Non-lethal weapons

- Reconnaissance, surveillance, and target acquisition (RSTA) systems

(2) Identify tasks involved in AAR preparation, OC coordination and mentoring, and THP construction.

(3) Formulate strategies to reduce OC and TAF analyst workload, based on derived tasks.

(3) Identify payoffs in task reduction achieved by each strategy.

Scope

The study is an original effort analyzing the impact of future systems on force-on-force exercise control and feedback functions from platoon through Bn TF level at the following training facilities:

- National Training Center (NTC)

- Combat Maneuver Training Center (CMTC)

- Joint Readiness Training Center (JRTC)

- Home-station

This study provides strategies to reduce OC and TAF analyst workload but offers no technical solutions. The study does not provide an analysis of task criticality, complexity, duration, or

frequency for the exercise control and training feedback tasks identified.

Background

Simulation training facilities provide two types of feedback to exercise players: intrinsic and extrinsic feedback. Intrinsic feedback is "downrange" feedback provided to exercise players during the exercise from actual and simulated entities or activities. Extrinsic feedback is that feedback provided to the friendly/rotating unit (BLUFOR) in the form of AARs, OC coaching, and unit take home packages.

Intrinsic Feedback

Again, intrinsic feedback is "downrange" feedback provided to exercise players during the exercise as they interact with their tactical systems and other players. Intrinsic feedback consists of those real or simulated entities or activities that stimulate the senses of the players (sight, sound, smell, feel, and taste) and cause them to react to a condition or combination of conditions. Figure 1 provides examples of real and simulated intrinsic feedback. Actual terrain influences player maneuver, exercise players interact with other real players, commanders (Cdrs) respond to appraisals provided by real battle staffs, and staff members interact with real C4I systems. However, due to safety or cost constraints, many entities and activities are simulated such as the visual (flash), audio (bang), and casualty-producing effects of weapons; a higher, supporting, or adjacent unit; and ammunition resupply. Figure 2 provides an example of intrinsic feedback during a direct fire engagement.

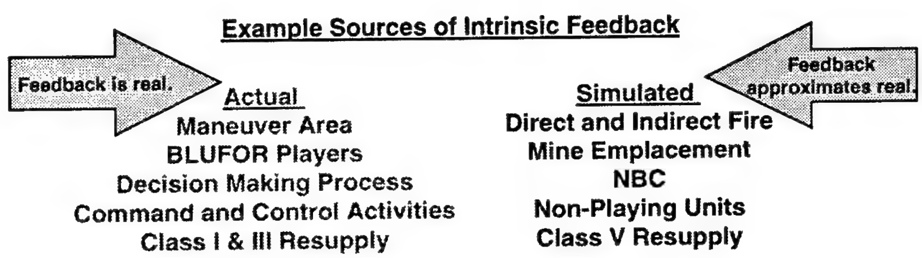


Figure 1. Example sources of intrinsic feedback

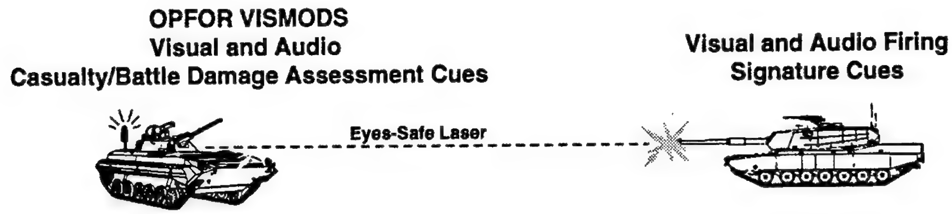


Figure 2. Intrinsic feedback

The live OPFOR visually modified (VISMOD) vehicle provides the BLUFOR crew the intrinsic feedback needed to distinguish enemy vehicles from friendly vehicles. The TES system simulates the flash and bang of the firing BLUFOR vehicle creating a signature for acquisition by the OPFOR vehicle. The BLUFOR vehicle TES also emits a harmless/eye-safe laser during the engagement. Sensors on the OPFOR vehicle detect the strike of the laser beam and actuate a continuously blinking amber light simulating a vehicle kill. The blinking light informs the OPFOR crew that their vehicle is out of action and notifies the BLUFOR crew that they destroyed the OPFOR vehicle. Both the firer and the victim received actual and simulated intrinsic feedback on their actions during the engagement. The firer received feedback indicating that his fires were accurate. The victim received feedback indicating that his use of cover and concealment was inadequate.

NOTE: In this study, we refer to BLUFOR and OPFOR entities collectively as exercise players.

Exercise Control

TES systems and OC/TAF analyst control actions simulate various entities and activities. When the TES system fails to provide intrinsic feedback based solely on BLUFOR and OPFOR actions, OCs and TAF analysts perform exercise control to provide player personnel the needed feedback. See Figure 3 for an example of exercise control.

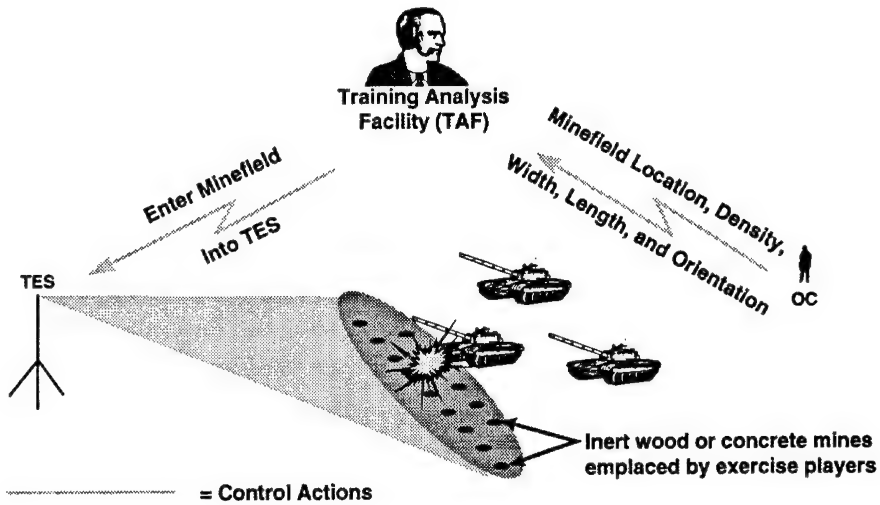


Figure 3. Intrinsic feedback and exercise control

In Figure 3, the BLUFOR emplaced inert wood or concrete mines to simulate an anti-armor minefield, and an OPFOR tank subsequently ran over one of the simulated mines. In this case, BLUFOR and OPFOR actions were not sufficient to produce the signature (flash and bang) of the mine exploding nor to assess the battle damage inflicted against the OPFOR tank. To produce the appropriate battlefield visual and audio effects and assess battle damage and casualties, OC and TAF analysts performed control actions employing the Simulated Area Weapons Effects (SAWE) TES system. SAWE simulates the effects of area weapons such as artillery, mortars, chemical agents, and minefields. In this example, the analyst entered the minefield's location and technical data into the SAWE control station. SAWE compares the location of player entities to the geographic area affected by the minefield and electronically assesses casualties and battle damage for those vehicles entering the minefield. To produce the signature of exploding mines, SAWE activates Audio Visual Devices (AVDs) installed on player vehicles. The AVDs launch pyrotechnics simulating the "flash and bang" of exploding mines. SAWE assesses dismounted personnel casualties by activating the audio alarm on the soldier's Man Worn Laser Detector (MWLD).

OC and TAF analyst control tasks and TES actions are summarized below:

(1) The OC, collocated with the BLUFOR unit, provided the location, type mines, density, width, length, and orientation of the minefield to the analyst located in the TAF.

(2) The TAF analyst entered the minefield information into SAWE.

(3) When SAWE sensed the OPFOR tank's encroachment of the BLUFOR minefield in Figure 3, SAWE actuated the signature for the exploding minefield and assessed battle damage to the OPFOR tank.

Control Requirements for Line of Sight (LOS) Engagements

The Multiple Integrated Laser Engagement System (MILES) automatically produces visual and audio battlefield effects and assesses battle damage and casualties for direct fire engagements. MILES uses an eye-safe laser beam and laser beam detectors on target vehicles to simulate the effects of LOS weapons. However, because MILES laser-based technology has fidelity limitations, OCs occasionally perform exercise control actions. MILES lasers will not penetrate minor obstructions. Tree leaves ("tree-leaf defilade") will obstruct the laser. Firing positions with berms ("MILES berms") that are inadequate to stop penetration by real ordnance will stop a MILES laser beam. Smoke and dust precludes the effectiveness of the laser and may preclude engagements at maximum range. For safety, JRTC rules of engagement preclude the use of MILES by dismounted soldiers for close-in engagements at less than 10 meters. OCs manually perform exercise control using laser pistols (control guns) in those instances where MILES fidelity limitations or safety preclude automatic casualty and battle damage assessments. See Figure 4 for the three types of LOS engagements supported by MILES.

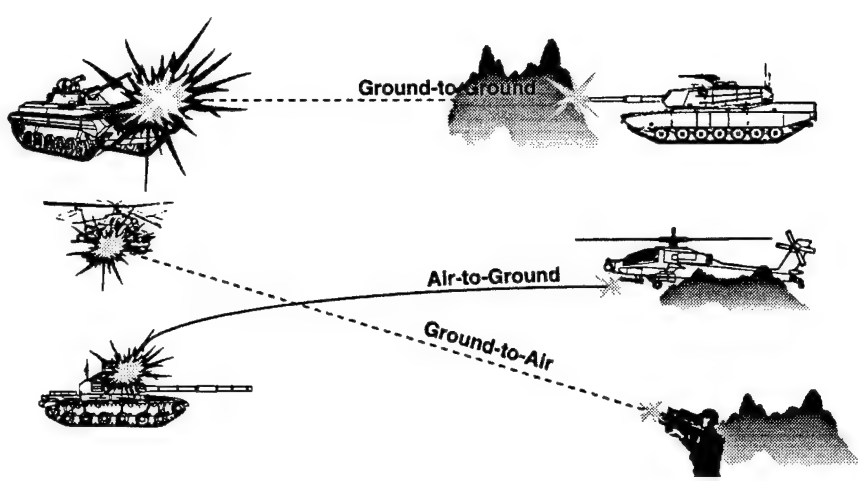


Figure 4. Three types of LOS engagements

Control Requirements for Non-Line of Sight (NLOS) Engagements

The MILES TES system is not capable of simulating NLOS engagements. Figure 5 provides an illustration of the complex control procedures necessary to provide intrinsic feedback to exercise players for indirect fires/NLOS engagements, in this case, a Copperhead fire mission.

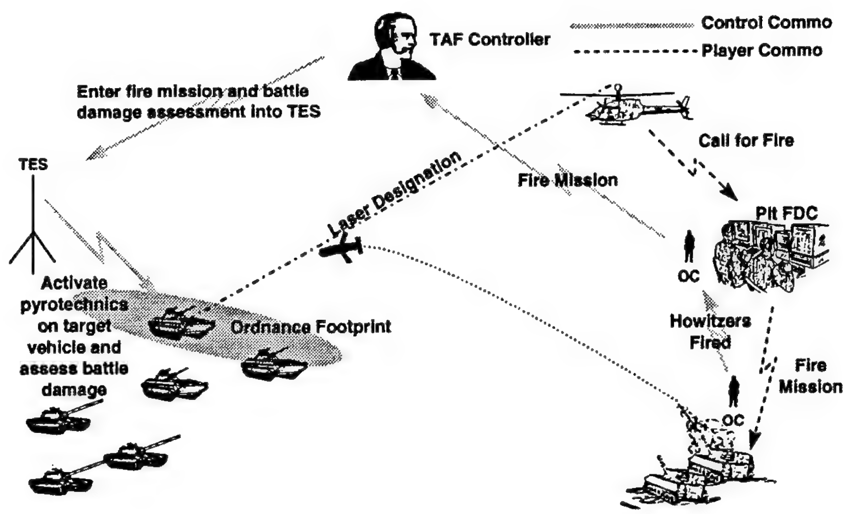


Figure 5. Control actions - indirect fires

To produce the appropriate battlefield effects and battle damage/casualty assessments for indirect fires, trainers must perform extensive control actions:

(1) The OC, collocated with the howitzer platoon fire direction center (FDC), monitors the call for fire from the aerial observer and observes the FDC's procedures in the determination of fire mission data. The FDC OC also passes the target location, projectile type, number of projectiles to be fired, and firing unit(s) to the TAF analyst for entry into the TES system--SAWE.

(2) A firing platoon OC observes the actions of the howitzer platoon in preparing for the mission. In this example, the fire mission calls for Copperhead projectiles. The firing platoon OC notifies the FDC OC of whether or not the firing platoon prepared the Copperhead training round and laid the howitzers correctly.

(3) The FDC OC assesses the aerial observer's procedures during the Copperhead engagement by monitoring the coordination between the FDC and the observer during

the course of the fire mission. There are no means to determine if the aerial observer was aiming his laser designator at a target within the Copperhead maneuverability footprint during the engagement.

(4) The TAF analyst fires the mission in the SAWE control station to depict the indirect fire vector on his top-down view of the exercise. Next, he looks for the satisfaction of two conditions before assessing effects against the OPFOR:

- First condition--the FDC OC confirms that the observer, FDC, and howitzers executed all procedures correctly.

- Second condition--there are OPFOR vehicles within the Copperhead maneuverability footprint. (The TAF analyst uses his top-down view of the exercise to ascertain this.)

If these two conditions are met, the TAF analyst manually registers a hit or kill on a vehicle within the Copperhead footprint. If these two conditions are not met, the TAF analyst assesses no damage against OPFOR and notes the reasons why the fire mission was not successful.

Other Exercise Control Requirements

There are other factors which drive exercise control requirements. The BLUFOR unit establishes its training objectives for a rotation (or series of exercises) during pre-rotational coordination. Exercise and scenario developers design the tactical missions and prepare supporting operations orders well before the unit arrives in the training area. During the rotation, exercise controllers (i.e., NTC Division Tactical Operation Center [DTOC] controllers) ensure that the BLUFOR unit has the opportunity to accomplish its training objectives for the rotation by altering:

- The unit's Mission
- The Enemy situation
- Exercise Terrain and weather (i.e., night attack)
- Troops and Time available

METT-T is the acronym for all of the above factors collectively. The exercise controller influences the unit's METT-T during the planning, preparation, and execution phases of each tactical mission. In performing his control duties, the exercise controller may role play as elements of higher, adjacent, or supporting units and transmit reports, operations orders, and overlays to the BLUFOR unit to paint the tactical situation and cause the players to respond. The exercise controller also controls the activities of the OPFOR to ensure that OPFOR behavior is realistically represented during the course of the exercise.

Extrinsic Feedback

Extrinsic feedback is that feedback provided to the BLUFOR in the form of AARs, coaching, and unit THPs. See Figure 6.

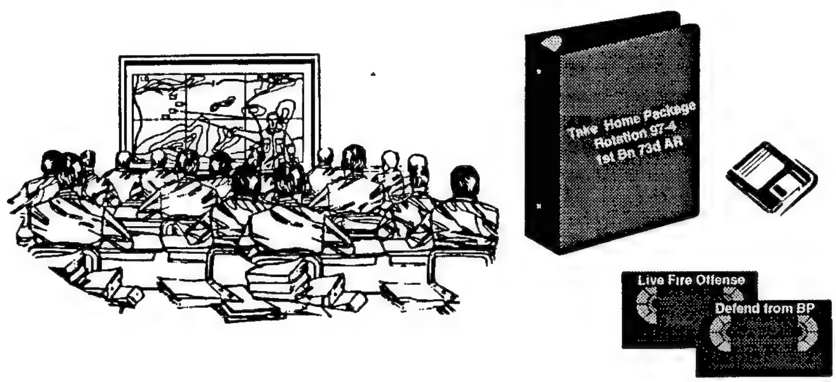


Figure 6. Extrinsic feedback

The AAR

The AAR is a dynamic discussion among the BLUFOR exercise players following an exercise in which the key leadership of the unit strives to determine: "What happened," "Why it happened," and "How to improve performance." The BLUFOR players are guided in their discussion by an AAR facilitator/leader, trainer, or OC. In this report, we refer to the AAR facilitator/leader as the OC. The OC guides player discussions to establish the causes and effects that led to the outcome of the battle through the use of various multimedia displays or AAR aids. These AAR aids present the tactical mission, task standards, and unchallengeable "ground truths" on BLUFOR's performance. AAR aids may be:

- Word slides (i.e., the unit's mission and the tasks and standards associated with that mission, a listing of areas requiring improvement)

- Computer-generated imagery displaying tactical control measures and animated and still views of player activity

- Tactical voice and digital communications revealing the command and control exercised by the unit's key leaders during a particular tactical event

- Statistical tables or graphs summarizing the unit's performance during the exercise or during a significant tactical event.

- Video clips of specific player actions (i.e., breaching an enemy obstacle) or examples of desired performance (i.e., good camouflage discipline and well prepared fighting positions)

AAR aids display the unit's plan (what was supposed to happen), identify "what happened" during the execution, and stimulate player discussions on "why it happened." During these discussions, BLUFOR players learn from their mistakes and benefit from the lessons learned by other players. The AAR, in effect, becomes the bridge between the completed training event and the next training event, providing post-exercise learning on "how to improve" that enables leaders to fix training weaknesses.

TAF analysts, in coordination with their OC counterparts, prepare AAR aids for the OC's unit, staff, or support slice (i.e., company team, tactical operations center [TOC], supporting engineer unit) and for the senior OC's Bn TF AAR. The preparation of AAR aids is extremely labor intensive. TAF analysts and OCs conduct AAR preparations as well as perform control functions before, during, and after the exercise. Figure 7 depicts the vertical and horizontal coordination among OCs and TAF analysts for AAR preparations.

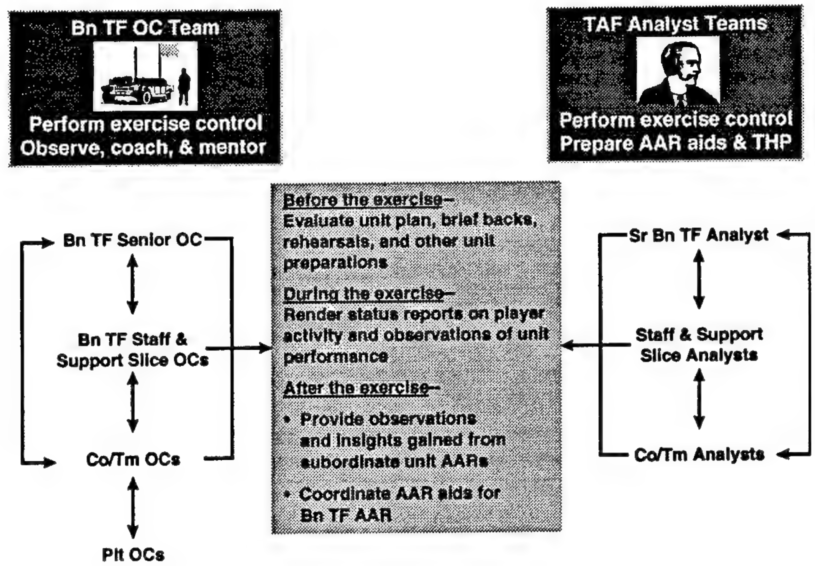


Figure 7. OC and TAF teamwork

AAR Preparations Before the Exercise. Before the exercise, OCs observe BLUFOR's decision-making process and operations order (OPORD) preparation. When BLUFOR completes planning, TAF analysts and OCs review BLUFOR's OPORD, applicable mission training plan (MTP) standards for the tactical mission, and the OPFOR OPORD. TAF analysts and OCs confer on the BLUFOR OPORD, then TAF analysts prepare AAR aids to illustrate the strengths and weaknesses in BLUFOR planning and preparations.

While OCs observe BLUFOR brief backs and mission rehearsals, TAF analysts enter the unit's overlays and planned and actual obstacle locations into the TES. Concurrently, other TAF analysts enter BLUFOR and OPFOR pre-planned artillery and mortar targets into the TES and position firemarkers and smoke generators in the exercise area based on the BLUFOR fire support plan. Senior OCs also prepare a control and observation plan on where to position OCs during the battle to preclude unobserved/uncontrolled events and the compromise of BLUFOR and OPFOR dispositions.

Before the exercise, TAF personnel also analyze the BLUFOR plan and unit preparations, in coordination with other TAF analysts, and prepare AAR aids on significant findings. For example, a fire support analyst and an intelligence analyst may compare known, suspected, and likely enemy positions appearing in the OPORD's intelligence annex with planned targets in the fire support annex, then prepare an AAR aid showing disconnects in planned targeting.

AAR Preparations During the Exercise. During the exercise, TAF analysts and OCs exchange information on their respective observations. As his control duties permit, the TAF analyst prepares AAR aids reflecting BLUFOR's performance during mission execution. The TAF analyst may prepare one or more AAR aids, using different media, to depict an aspect of BLUFOR performance. For example:

- Audio clip of the scout platoon leader's radio transmission to the TF Cdr upon the platoon's spotting of an OPFOR obstacle

- Animated, top-down/two-dimensional (2D) views depicting the effectiveness of BLUFOR's direct and indirect fires in suppressing OPFOR during BLUFOR breaching operations

- Video clip to show the effectiveness of BLUFOR smoke in obscuring OPFOR's vision during BLUFOR's maneuver to secure the far side of the obstacle

- Statistical shooter/victim table to summarize the results and outcome of the breaching operation

In addition to those AAR aids prepared to support the senior OC's Bn TF AAR, the TAF analyst prepares aids to support the junior OC's unit, staff, or support slice AAR. The analyst prepares AAR aids on the fly during the battle and during the brief period between end of mission and the senior OC's review of Bn TF AAR aids prepared for the exercise.

The TAF analyst and his counterpart OC record incidents where they interfered with player actions during the course of the exercise. For example, the OC may interrupt the BLUFOR players in the execution of a tactical mission to conduct some heavy player coaching, then resurrect casualties and restart the exercise. The OC also annotates reasons for control gun kills; i.e., BLUFOR vehicle behind MILES berm engaged by OPFOR BMP. Agencies, such as the Center for Army Lessons Learned (CALL) that perform post-rotation analysis, may draw some erroneous conclusions about the outcome of the exercise without this documentation.

AAR Preparations After the Exercise. The OC links his observations to key issues or teaching points and identifies the key issues that most affected battle outcome. Then the OC links key issues to exercise objectives and military doctrine and coordinates with his counterpart TAF analyst on AAR products. A designated OC(s) coordinates key issues with the OPFOR to ensure consistency in training feedback during the AAR.

The TAF analyst informs the OC of the AAR aids prepared and to be prepared for the senior OC's review, as well as those aids prepared for the junior OC's AAR. The primary focus of AAR preparations is on the Bn TF AAR. The OC conducts the AAR for his BLUFOR unit, staff, or support slice, then out-briefs the senior OC. The junior OC briefs the senior OC on:

- Junior OC and TAF analyst observations and performance assessments

- Any significant information that surfaced during the junior OC's AAR

- AAR aids prepared by the TAF analyst for the Bn TF AAR

Meanwhile, the TAF analyst constructs the Bn TF AAR aids he was unable to prepare before and during the exercise. Two to three hours before the AAR, the senior OC reviews each aid in an AAR van or theater. The senior OC selects the aids to be presented during the AAR, based on those BLUFOR actions that had the greatest impact on battle outcome, then conducts the AAR with the BLUFOR key leadership.

To summarize--today's AAR preparations are extremely labor intensive and require many highly-trained OCs and TAF analysts who are unchallengeable in their tactical and technical competence. Additionally, TAF analysts must be highly skilled in the operation of a complex AAR system to prepare timely multimedia AAR products for Bn TF AARs, as well as company level, staff, and support slice AARs.

OC Coordination and Mentoring

OCs perform a host of duties that are not evident from an analysis of intrinsic and extrinsic feedback requirements for emerging systems or from an analysis of AAR and take home package preparations. OCs perform direct observations of human behavior, such as the interaction among commanders and staff officers. To maximize BLUFOR training benefits, OCs take advantage of opportunities to coach and mentor their player counterparts during mission planning and preparation and exercise pauses. The OC may coach a player counterpart who is stumbling during the preparation of a staff estimate or in planning a mission rehearsal. OCs perform risk assessments regularly and cross-check their assessments with their player counterparts, proactively identifying safety issues and recommending measures to reduce risk. Coaching and mentoring are key OC contributions to the improved training readiness achieved by the rotating unit.

Take Home Package (THP) Preparations

Trainers provide the unit a THP at the conclusion of the unit's training cycle/rotation. The THP may consist of a written portion describing the exercises conducted by the unit, tasks performed to standard and tasks requiring improvement, and a video portion containing all of the unit's AARs and other training highlights. The unit uses the THP to assess its training status for each task listed in their Mission Essential Task List (METL) and to develop near- and far-term training plans to sustain acquired skills and to correct training weaknesses.

OCs prepare their respective written portions of the THP as the rotation or series of exercises progresses. At the conclusion of the rotation, each OC provides his portion of the THP to the senior OC for review and comment. Upon his final review, the senior OC submits the written portion of the THP to the TAF for production and distribution to the rotating unit.

In addition to the written portion of the THP, the TAF video section compiles video tapes of platoon, company, staff, support slice, and Bn TF level AARs conducted during the unit's rotation. Editors also condense video footage and prepare video packages showing highlights of the unit's training.

Upon departure, or soon after departure from the training site, the rotating Bn TF receives a multimedia THP--which may be large enough to fill a footlocker. There is a move at JRTC and CMTC to reduce the size of the THP and to focus on key issues. For example, at JRTC the OCs prepare a one page assessment for the Bn TF and a one page assessment for each subordinate and supporting unit. Each assessment addresses the key issues that surfaced during the unit's rotation and points out three unit strengths and three training weaknesses. OCs also prepare similar one page assessments for each BOS.

JRTC

Up to this point, we have presented background information on the CTCs with an orientation toward mounted operations. During the course of the study, we had the opportunity to visit the JRTC and collect information on OC and TAF control and feedback tasks for dismounted operations. We interviewed 22 OC/TAF analysts during our visit. The comments below reflect the highlights of our JRTC interviews. We recognize that some of the comments may be applicable to other CTCs as well.

Light infantry units differ from heavy units in that the former perform most of their operations with minimal support by organic vehicles. Mission planning and preparation are often more critical for light infantry because their slow rate of movement and need to link up with supporting vehicles for casualty evacuation and resupply leave little margin for error. Finally, most light infantry engagements are within 50 meters or less in wooded areas. These differences influence exercise control and feedback in the ways described below.

(1) OCs at company level and below usually follow units dismounted to observe the behavior of their BLUFOR counterpart. Rather than monitor BLUFOR tactical nets, the JRTC OC positions himself near his BLUFOR counterpart and eavesdrops on his counterpart's radio or telephone transmissions. To determine the response to the message, the OC uses his Observer Controller Communication System (OCCS) radio and contacts the OC collocated with the BLUFOR player who received the message. The two OCs then piece together the two ends of the conversation.

(2) Due in part to the increased importance of planning and preparation for light infantry, JRTC places an increased emphasize on realistic play of combat service support functions.

(3) While all CTCs emphasize continuous operations to stress the rotating unit, rotating unit actions or in-actions at JRTC influence follow-up operations to a greater extent than at the other CTCs. For example, if BLUFOR locates and destroys an OPFOR ammunition cache, that ammunition is unavailable to OPFOR during future operations.

(4) For reasons of safety, OCs perform intensive control actions when dismounted BLUFOR and OPFOR personnel come directly in contact with one another during close-in engagements. Such close contacts are the rule at JRTC, but they are the exception at other CTCs.

(5) Because of densely wooded terrain and low lying areas, the JRTC instrumentation system has difficulty receiving signals from Personnel Detection Devices (PDDs) worn by individual soldiers. JRTC OCs compensate for this problem by sending reports and observations to TAF analysts on the status and activity of BLUFOR units and leaders down to the squad level. The TAF analysts, in turn, manually record and timeline the information for entry into their instrumented

workstations. Both OCs and TAF analysts are tied up supporting data collection on the status (i.e, casualties, ammunition on hand, hours without sleep), location, and activity of small dismounted units. The hindrance of data transmissions by overhead cover and terrain requires modification of current and proposed instrumentation systems to meet the light infantry situation. Further, the 16 pound PDD vest that individual soldiers wear to support the instrumentation system is unsuitable for dismounted operations. At JRTC, individual equipment, weapon, and ammunition impose a heavy load on BLUFOR soldiers, so OCs wear the PDD.

JRTC does not have sufficient OCs to support training and relies heavily on the use of augmentation OCs. Because there is a substantial variation among rotational units (i.e., airborne, air assault, and light units) and their equipment, JRTC is unable to provide OCs for all units in the BLUFOR task organization. JRTC calls upon US Army Training and Doctrine Command (TRADOC) schools, US Army Readiness Regions, and nonplaying personnel from the BLUFOR unit's home installation to meet OC requirements.

There are already a number of light infantry weapons that cannot be employed by the BLUFOR at JRTC because there is no TES system or the manning requirements to support control procedures for simulation of the weapons are impractical. Weapons not played at JRTC include the MK19 40mm Grenade Machine Gun, the M203 Grenade Launcher, hand grenades, and the Claymore mine.

JRTC assesses casualties for individual mines, while the other CTCs are concerned with control activities involving minefields. Observation and control of individual mines places a major burden on OCs and may involve 26 or more OCs assessing casualties caused by BLUFOR and OPFOR mines.

Whether or not control duties interfere with OC observing, coaching, and mentoring varies among duty positions. OCs who routinely control engagements are subject to being overcome by control requirements at the expense of observation duties, depending on the extent of their BLUFOR counterpart's interaction with the OPFOR. Coaching and mentoring appear to be less disrupted by control duties for some duty positions, because sufficient "down time" exists for the OCs to perform coaching sessions. However, combat service support (CSS) OCs report they are too busy counting, controlling, and collecting data over widely dispersed locations to perform coaching and mentoring, even during the planning and preparation phases.

JRTC OCs informed us that direct observation of leaders and soldiers is usually sufficient to identify unit strengths and weaknesses and that collection of battle damage assessment (BDA) data is not crucial to diagnosing problems in unit performance. However, BDA information is useful in documenting outcomes and supporting discussions on how unit strengths and weaknesses influenced battle outcome. Except for highly polished units, sophisticated and instrumented measures of performance are not usually needed to identify performance problems to be addressed in AARs. However, such measures may be needed to prepare hard-hitting, credible AAR aids that clearly show unit performance and evoke dynamic discussions.

In the eyes of the BLUFOR player, the credibility of the exercise is diminished when they see the "00" MILES kill code produced by the OC control gun (i.e., "OPFOR didn't kill me--the OC did!"). There are further credibility problems when manually intensive control procedures result in the assessment of casualties several minutes after a successful engagement. JRTC personnel indicated that the control procedures to simulate weapons effects for certain weapons interfered with player actions. For example, the time required for an OC to move around on the ground and assess casualties after an attack helicopter engagement may prevent the OC from assessing a subsequent engagement by the same helicopter at a different location. In some cases, the need for OCs to approach targets for exercise control purposes has the effect of compromising player locations.

At present, the "crescendo of AAR preparation" occurs at the "crescendo of action in the field." TAF analysts are busy preparing aids for the Bn TF AAR when OCs are trying to submit reports from the field. The heavy report load is due, in part, to the need for OCs to radio information to the TAF regarding each casualty.

A few OCs have had experience with digitized communications. In these cases, the OCs and TAF analysts did not have access to their own system for monitoring the flow of digital messages. Instead, the OCs asked their BLUFOR counterparts to print out copies of messages sent and received as a short-term solution. Better methods are required for OCs to monitor these messages in a less obtrusive manner.

Impact of Force Modernization

We researched the Army Science and Technology Master Plan to identify emerging tactical systems at the Bn TF level and below. To identify the impact of force modernization on exercise control and training feedback functions, we identified the intrinsic and

extrinsic feedback requirements of each emerging tactical system. We contrasted these requirements with the current capabilities of TES and instrumentation systems then determined the OC and TAF analyst control and data collection tasks imposed by each force modernization initiative. See Figure 8.

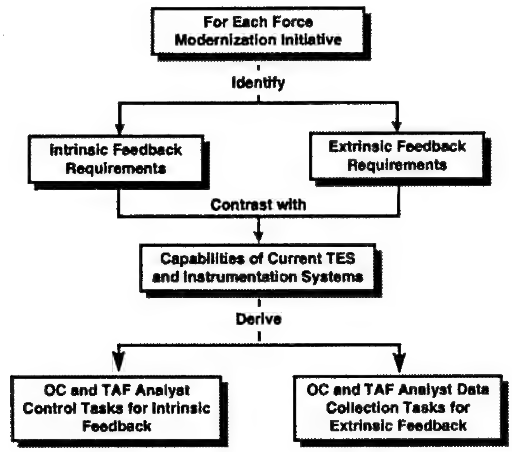


Figure 8. Assessing the impact of force modernization

To structure our research and analysis and support requirements for future data manipulation, we constructed and populated a Microsoft Access relational database. To assist us in our visualization of each tactical system's operation, we prepared illustrations of each system's employment, identifying the intrinsic and extrinsic feedback requirements. In these illustrations we annotated whether the TES, instrumentation system, or an OC/TAF analyst provided the necessary feedback for simulated entities and activities. We also annotated feedback voids for those instances where neither the TES, instrumentation system, nor OC/TAF analysts could provide the needed feedback.

Analysis of Intrinsic Feedback

Our sole interest in intrinsic feedback is to identify exercise control activities that impact on TAF analyst or OC workload. Recall that intrinsic feedback is "downrange" feedback provided to exercise players during the exercise as they interact with their tactical systems and other players. Intrinsic feedback consists of those real or simulated entities or activities that stimulate the senses of the players (sight, sound, smell, feel, and taste) and cause them to react to a condition or combination of conditions. Also recall that when the TES system fails to provide "downrange" feedback for simulated conditions based solely on BLUFOR and OPFOR actions, OCs and TAF analysts must perform control procedures to stimulate exercise players.

We performed the following analysis to identify the intrinsic feedback requirements for emerging weapon systems.

(1) We identified the Battlefield Operating System (BOS) for each weapon system and categorized the system as line of sight (LOS), non-line of sight (NLOS), or both LOS and NLOS. We determined the type of engagements the system supported--ground-to-ground, ground-to-air, and air-to-ground. We also identified:

- Intended targets for the weapon system
- Target acquisition procedures
- Target hand-off procedures (if applicable)
- Engagement procedures
- Target tracking procedures
- Fire-and-forget mode capabilities (if applicable)
- System countermeasures

(2) After we gained a thorough understanding of the weapon's capabilities and operation, we identified the intrinsic feedback required for the shooter and the victim during employment of the weapon system in force-on-force training. We identified feedback that was real (interaction of the players with actual entities and activities) and feedback requiring simulation.

(3) For simulated entities and activities, we compared the simulation requirements to the capabilities of the TES system to identify:

- Feedback provided by the TES system
- Feedback provided by OC and TAF analyst control actions
- Feedback voids

We also researched maneuver Combat Training Center (CTC) rules of engagement and OC handbooks to identify OC and TAF analyst control activities and TES capabilities and limitations. We gained further insights into TES capabilities and exercise control requirements from discussions with Project Manager

Training Devices (PM TRADE) representatives and site visits to CMTC and JRTC.

(4) In our next step we derived tasks for each control action indicating whether an OC or TAF analyst performed the control task. Figure 9 provides a diagram of our methodology to determine the impact of emerging weapon systems on OC and TAF analyst control functions.

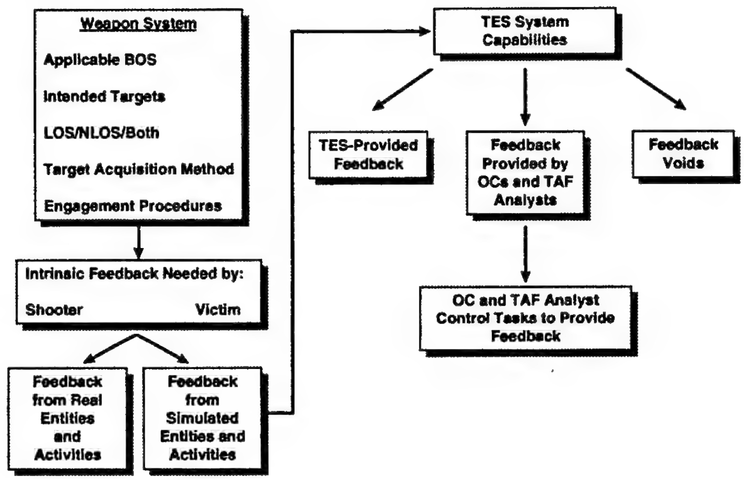


Figure 9. Analysis to identify control tasks

Our analysis of C4I, Decision Support, and RSTA systems followed procedures similar to the weapon system methodology described above.

AH-64D Intrinsic Feedback Requirements

To promote understanding of the study's methodology, we will walk through our analysis of intrinsic feedback requirements for a sample weapon system--the AH-64D Longbow Apache Helicopter.

The Longbow Apache has a mast-mounted millimeter wave fire control radar (FCR), a radar frequency interferometer (RFI), and a radar frequency fire-and-forget Longbow Hellfire missile. The Longbow Apache uses a millimeter wave (MMW) radar targeting system that can function in day, night, adverse weather, and battlefield obscurant situations. The Longbow Apache's digitized target acquisition system provides automatic target detection, location, classification, prioritization, and target hand-over to onboard Longbow Hellfire missiles. The Longbow Hellfire is a true fire-and-forget missile that uses an internal MMW seeker to locate targets designated by the Apache fire control system. The missile contains the target location and a radar "picture" of the

target when launched. The MMW seeker in the nose of the missile "seeks" the radar image, locates the target, then maneuvers the missile toward the target. The Longbow Hellfire increases survivability for MMW countermeasures and has an advanced warhead to defeat all known armor to include reactive armor variants (DoD, 1996).

In Figure 10 an AH-64D Longbow Apache is engaging a BMP in a non-line of sight (NLOS), fire-and-forget mode. Below the AH-64D and the BMP are listings of the "down range" feedback required by the shooter and victim/target respectively.

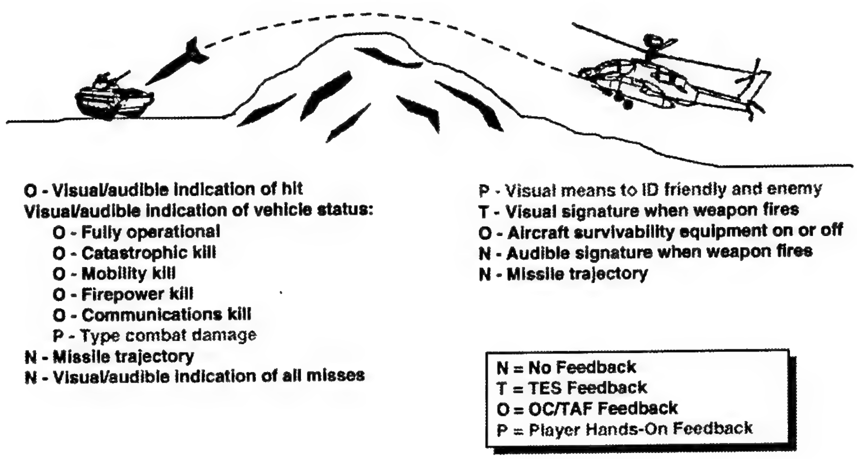


Figure 10. AH-64D intrinsic feedback requirements

The legend in Figure 10 breaks down the intrinsic feedback requirements by source-

P -- Actual feedback obtained by the players from hands-on interaction with their tactical equipment or other players

T -- Simulated feedback provided by the TES

O -- Simulated feedback provided by OCs and TAF analysts (includes firemarkers)

N -- No feedback provided

A live OPFOR provides the necessary stimulation to initiate the engagement by the AH-64D. The aircrew can acquire the target using on-board fire control equipment (P). A strobe light on the weapon pod flashes to simulate the signature of the firing missiles, and a light in the cockpit alerts the crew of missile launch (T). There is no simulation for the sound of firing missiles or for the missile's trajectory (N). Since the AH-64D

is firing from a defilade position in an NLOS mode, MILES laser technology will not support simulation of the engagement. To simulate Longbow Hellfire missile NLOS engagements, TAF analysts and OCs must perform intensive control actions to simulate the missile's impact and assess battle damage (O). The OC must also determine if the crew employed aircraft survivability equipment to defeat OPFOR air defense engagements (O). Neither OCs/TAF analysts nor TES can provide the shooter or victim feedback on the location of impacting ordnance for missed shots (N).

We are not suggesting that the government develop IS and TES systems to provide intrinsic feedback on all the N-coded (no feedback) and O-coded (OC/TAF feedback) items in this report. In our analysis we identified the intrinsic feedback the soldier or crew may receive during actual employment of the combat system. We contrasted our analysis results with the capabilities of the TES, IS, OCs, and TAF analysts to provide the feedback and identified feedback shortfalls. A follow-on analysis is required to determine which N- and O-coded items are cost and training effective to implement in future IS and TES systems.

AH-64D Control Tasks

Figure 11 lists OC and TAF analyst control tasks required to generate feedback on the O-coded items in the previous figure.

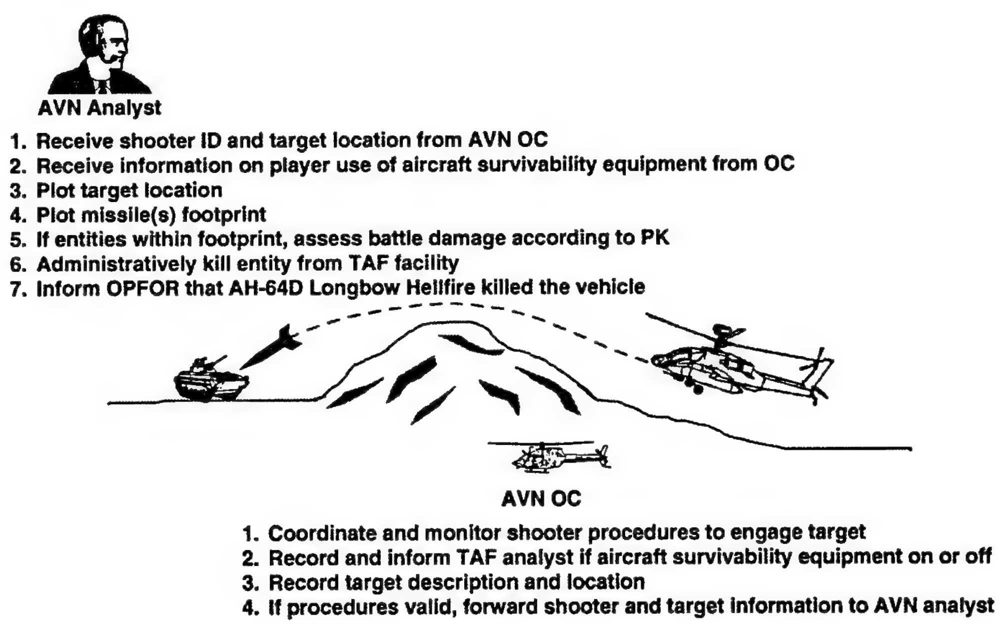


Figure 11. AH-64D control tasks

To simulate the engagement, the AH-64D aircrew notifies an airborne OC over a voice control net when the aircrew has located a target(s) to engage. The OC informs a TAF analyst of the intended engagement, and the TAF analyst annotates the target location(s) and the missile(s) footprint on his top-down view of the exercise. The pilot performs all engagement procedures the fire control system will permit without live missiles, then triggers the strobe light on the weapons pod signaling missile launch. If the OC determines that the crew performed all procedures correctly, the OC notifies the TAF analyst the engagement was valid. The OC also informs the TAF analyst if the aircrew employed on-board aircraft survivability equipment.

The TAF analyst compares the missile footprint to the location of OPFOR vehicles. If there are vehicles within the footprint, the analyst administratively kills one or more of the OPFOR vehicles based on a predetermined probability of kill (PK) and the number of missiles fired. The manually-entered kill code sent from the TAF causes the BMP's light to flash continuously, informing the crew and the shooter that the BMP has sustained combat damage.

In the event of a miss, neither the BMP nor the aircrew receive feedback on the impact location of the missing ordnance. However, if the ordnance impacted in close vicinity to the BMP, the amber light on top of the BMP will blink a few times to indicate a near miss.

Analysis of Extrinsic Feedback

Recall that extrinsic feedback is that feedback provided to the BLUFOR in the form of AARs, coaching, and THPs. We determined the extrinsic data needed to support AARs for each tactical system by:

- Identifying the capabilities of the tactical system
- Researching information on the system's tactical employment and operation
- Deriving the essential data needed to support assessment of the system's employment

Figure 12 depicts the extrinsic data required from each AH-64D attack helicopter to assess collective employment of the aircraft by the attack helicopter company or battalion. However, this data alone is not sufficient to prepare AAR products which support assessment of attack helicopter unit performance. The OC

and TAF analyst must couple the extrinsic data below with the unit's tactical plan, fire control measures, and fire commands to fully appraise the unit's performance. Information from unit command and control actions during the planning and execution of the operation is required to fully assess the employment of each system addressed in this study.

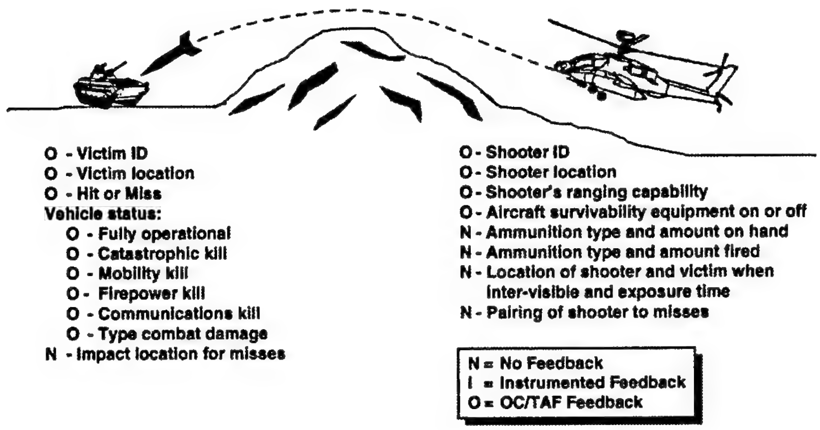


Figure 12. AH-64D extrinsic feedback requirements

After we derived the essential data needed to support assessment of the system's employment, we identified the sources for the data. We crosswalked the extrinsic data requirements with the capabilities of current instrumentation systems and identified the following data sources:

I -- Data collected by the instrumentation system

O -- Data collected by OCs or TAF analysts

N -- Data not collected

Again, the study's focus is to identify the impact of force modernization on OC and TAF analyst workload; therefore, we analyzed the OC and TAF analyst tasks necessary to collect the O-coded data. We discovered that OC and TAF analyst performance of control tasks not only supported player intrinsic feedback requirements but also supported collection of extrinsic O-coded data.

Analysis Results for Force Modernization Impact

The analysis supports 142 systems/technology demonstrations. As we analyzed the intrinsic and extrinsic feedback requirements of weapon, RSTA, and C4I systems, we found that our analysis of selected systems was applicable to other systems. When our

analysis supported the control and feedback requirements of other tactical systems, we designated the analyzed system as a "representative system." Appendix C lists 24 representative systems and 104 other systems (munitions, tactical systems, or technology demonstrations) supported by our analysis of the representative systems.

When we could not extend the analysis of a system to other systems, we designated the system a "special case." Appendix C identifies 14 special cases where our analysis is pertinent only to the analyzed system.

Our analysis of representative systems and special cases appear in the following Appendixes:

D Weapon Systems Analysis
E Weapon Systems Database
F RSTA Systems Analysis
G RSTA Systems Database
H C4I Systems Analysis
I C4I Systems Database

Appendixes D, F, and H contain illustrations of each representative system's employment and identify:

- Intrinsic feedback requirements
- OC and TAF analyst control tasks
- Extrinsic feedback requirements
- OC and TAF analyst data collection tasks

Appendixes E, G, and I are reports from the TAAF Aids database. The reports contain capability and tactical employment descriptions for each system, recap intrinsic and extrinsic data requirements, and list derived TAF analyst and OC control and data collection tasks.

In the paragraphs that follow, we will discuss the results of our analysis for one force modernization initiative from each of the following categories:

- Heavy Weapon Systems
- Light Weapon Systems
- Non-Lethal Weapon Systems
- RSTA Systems

- C4I Systems

For each system, we will address the system's capabilities and tactical employment, OC and TAF analyst intrinsic and extrinsic feedback tasks, and current TES and IS limitations in providing the desired feedback.

Analysis Results for a Heavy Weapon System

A detailed analysis of all representative weapon systems analyzed over the course of the study is in Appendix D. The following is an example of a heavy weapon system analysis--the M1A1/A2 Smart Target Activated Fire and Forget (STAFF) round.

STAFF Capabilities and Employment

The XM943 STAFF ammunition is the newest "smart weapon" compatible with M1A1/A2 120MM Abrams tank system. The ammunition searches for and destroys enemy armor at distances beyond the reach of conventional tank rounds. The system attacks targets from the "top down" and uses an explosively formed penetrator to destroy the target. Primarily designed for use against enemy armor, the STAFF round can also attack enemy helicopters. The tank crew can now increase its ability to engage targets seen briefly which then disappear behind intervening terrain. The top-down attack capability of the munition allows tanks to now engage targets in defilade. The STAFF round requires no additional crew training other than the requirement to set a single range zone switch on the round before firing. The STAFF is fin stabilized and orients itself vertically in relation to the ground during ballistic flight. After orientation during the last seconds of the flight, the weapon initiates a search and track mode looking for targets. It searches for targets with a millimeter wave sensor that establishes a large footprint on the ground for target detection. During ballistic flight as the round flies over a detected target, it rolls to orient the warhead and fires down into the target. The weapon is truly a fire-and-forget round that requires no tracking, allowing the gunner to quickly sight-in on other targets immediately after firing the STAFF round (Alliant, 1996b).

STAFF Intrinsic Feedback Requirements

Figure 13 shows two M1A2 Abrams tanks firing at two BMP's in defilade positions. The illustration lists the intrinsic feedback requirements necessary to simulate battlefield

conditions for the shooter (listed on right side) and for the victim (listed on left side). The legend identifies the source of the feedback for each intrinsic feedback requirement.

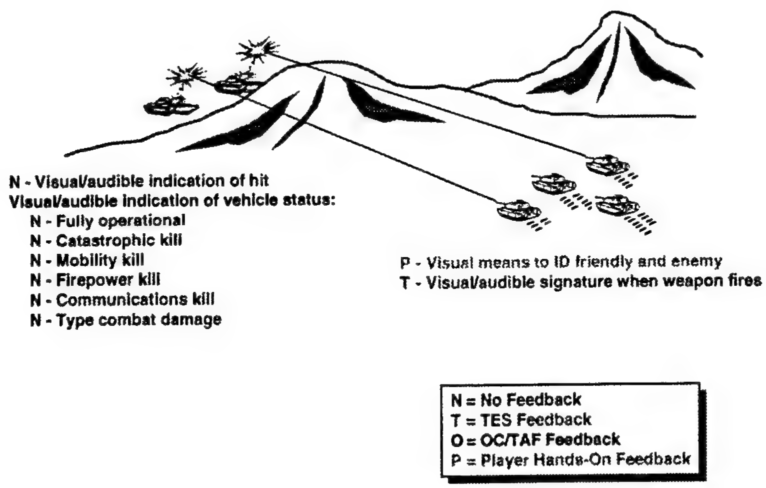


Figure 13. STAFF intrinsic feedback requirements

A live OPFOR visually modified vehicle provides the necessary feedback for the crew to discern enemy from friendlies (P). The weapon provides the crew with a visual and audible indication when the weapon fires using pyrotechnics mounted on the vehicle (T). Figure 13 depicts no feedback to the shooter for ordnance effects. The crew will not know if they hit or missed the target since intervening terrain blocks intervisibility (N). The victim may see the signature of the shooter as the victim maneuvers to a defilade position (T). These intrinsic feedback elements are the only feedback the shooter and victim receive with the current TES and IS. The current MILES laser system cannot simulate the top-down attack capability of the STAFF ammunition to provide the remainder of the intrinsic feedback needed by the shooter and the victim (the N-coded items).

STAFF Extrinsic Feedback Requirements

Figure 14 shows the extrinsic feedback data required to evaluate the BLUFOR's employment of the STAFF round.

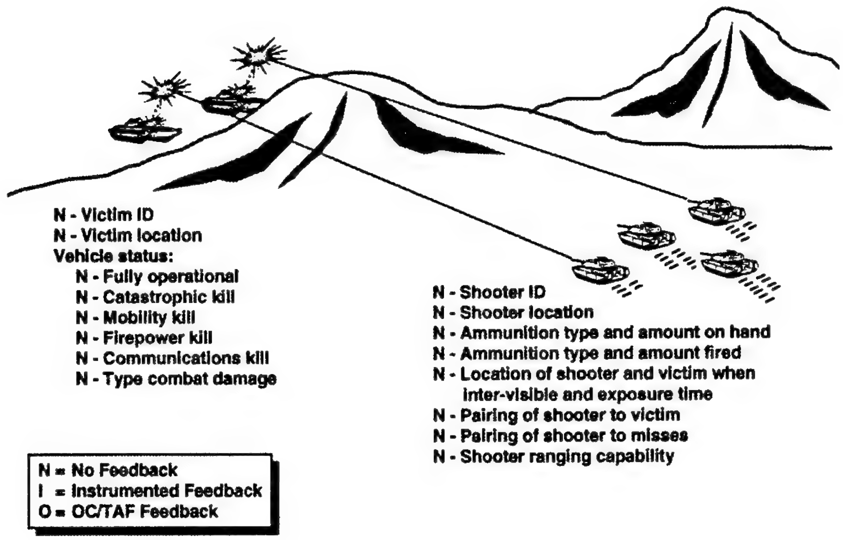


Figure 14. STAFF extrinsic feedback requirements

Current TES and IS cannot collect the extrinsic data elements required. Laser technology will not support simulation of the STAFF round's capability for a NLOS attack. The TES and IS cannot detect which tanks are firing LOS munitions and which tanks are firing the NLOS STAFF round, consequently, TES/IS cannot identify the shooter or collect any extrinsic data pertinent to the shooter.

STAFF Control and Data Collection Tasks

The OC and TAF analyst have no control or data collection tasks for this weapon system. It is impractical under current OC manning limitations to provide the players the intrinsic and extrinsic feedback needed for employment of the STAFF munition. In order to provide required feedback for the weapon, an OC must accompany every tank armed with the STAFF round. The tank commander would notify the OC of each STAFF engagement before firing. The OC would confirm that the STAFF round is onboard the tank. The OC would then confirm the target and notify a TAF analyst to prepare to assess damage against the victim in accordance with established probability of kill (PK) tables. If the OC with the shooter is satisfied with the engagement procedures of the shooter, he notifies the TAF analyst to administratively kill the vehicle. The described control procedures to compensate for TES and IS limitations are too manning intensive and are not timely or practical.

Analysis Results for a Light Weapon System

The following is an example of a light weapon system analysis--the Objective Individual Combat Weapon (OICW).

OICW Capabilities and Employment

The OICW will enhance the capability of the infantry soldier well into the 21st century. The system has the potential to selectively replace the M16 rifle, the M203 grenade launcher, and the M4 carbine in combat units. The capabilities of the OICW allow it to replace these three weapons with a single new weapon system. The weapon will have the capability of shooting 5.56mm and 20mm ammunition. The OICW has an effective range of 1,000 meters, allowing soldiers to engage targets at greater distances. The 20mm high explosive (HE) ammunition has a fusing capability that allows it to detonate at specific ranges. The weapon has a laser range finder that can determine distance to targets at ranges beyond 1,000 meters. This allows the soldier to determine the exact location of targets to "hand off" to artillery or mortar assets to engage. To engage targets with the HE ammunition, the soldier determines the exact range to the target with the range finder. The fire control system takes the range information and sets the 20mm ammunition fuses to detonate at that range. This feature will allow the soldier to engage targets that may be in defilade. The 20mm ammunition can defeat all personal armor protection systems in use. The uncooled IR sensors sighting system supports engagements day or night. The weapon also has a simple laser dot sighting system for rapid sighting in day or night conditions (Alliant, 1996a).

The OICW has a line of sight, and non-line of sight capability. For the non-line of sight capability, the soldier uses the OICW fire control system and the 20mm HE detonating fuse to engage targets in defilade. The intrinsic and extrinsic feedback requirements for non-line of sight engagements are similar to the M1A2 STAFF round. The following example addresses control and feedback requirements for employment of the OICW in LOS engagements.

OICW Intrinsic Feedback Requirements

Figure 15 shows the intrinsic feedback required by soldiers during employment of the OICW in a LOS mode. We address employment of the OICW in the NLOS in Appendix D.

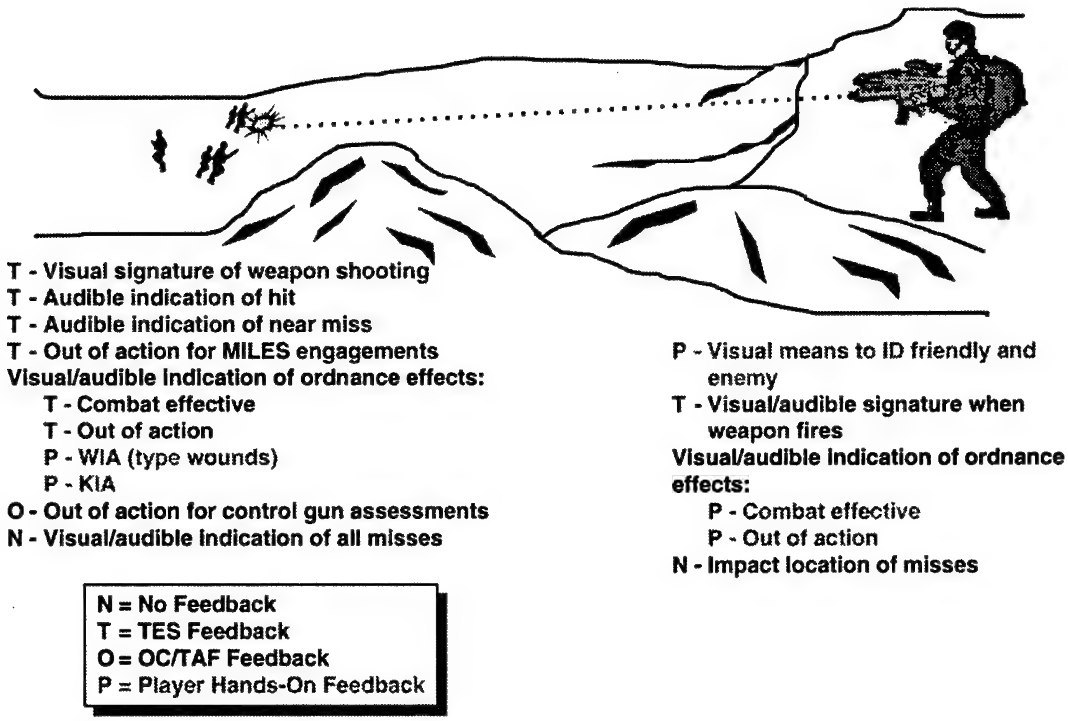
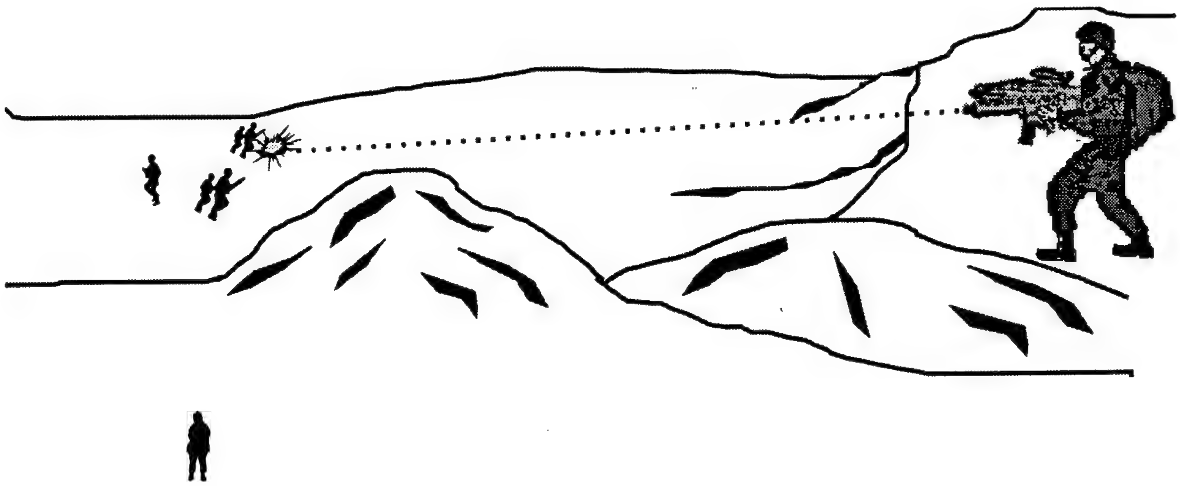


Figure 15. OICW intrinsic feedback requirements

OPFOR visually-modified vehicles and uniforms provide the player the ability to distinguish enemy from friendly (P). When the soldier fires, he receives a visual and audible signal from firing blank ammunition (T). The victim may see the visual signature of the shooter fire if close enough (T). If the shooter hits the target, he receives a visual indication of ordnance effects. The audio alarm on the victim's MILES harness activates, and the victim removes his helmet and sits-down signaling that he is out of action and a casualty (P). If the victim is hit and taken out of action (T), he consults his MILES casualty card to determine if he is wounded or killed (P). If wounded, the casualty card indicates the type wounds received (P). If not hit, the targeted soldier continues to be combat effective (T). There is no feedback to the shooter or the victim for the point of impact of missing ordnance (N). During the engagement, the OC may use his control gun to assess casualties to compensate for MILES limitations or to insure a fair fight.

OICW Control Tasks

Figure 16 shows the OC control tasks for the O-coded items in the previous figure.



PLT and CO/TM OCs

1. **Assess casualties for close-in engagements (less than 10 meters)**
2. **Assess casualties for rules of engagement (ROE) violations**
3. **Assess casualties for inoperative MILES**
4. **Assess casualties for MILES limitations:**
   "MILES Berms"
   "Leaf Defilade"
   "Canvas Defilade"

Figure 16. OICW control tasks

The OC may assess casualties with his control gun to promote safety, enforce rules of engagement, or compensate for MILES fidelity limitations. For safety, JRTC rules of engagement preclude the use of MILES by dismounted soldiers for close-in engagements at less than 10 meters. MILES lasers will not penetrate minor obstructions. Tree leaves and canvas will obstruct the laser. Firing positions with berms ("MILES berms") that are inadequate to stop penetration by real ordnance will stop a MILES laser beam. OCs manually perform exercise control using laser pistols (control guns) in those instances where MILES fidelity limitations or safety preclude automatic casualty and battle damage assessments.

OICW Extrinsic Feedback Requirements

Figure 17 shows the extrinsic feedback data required to evaluate the player's employment of the OICW.

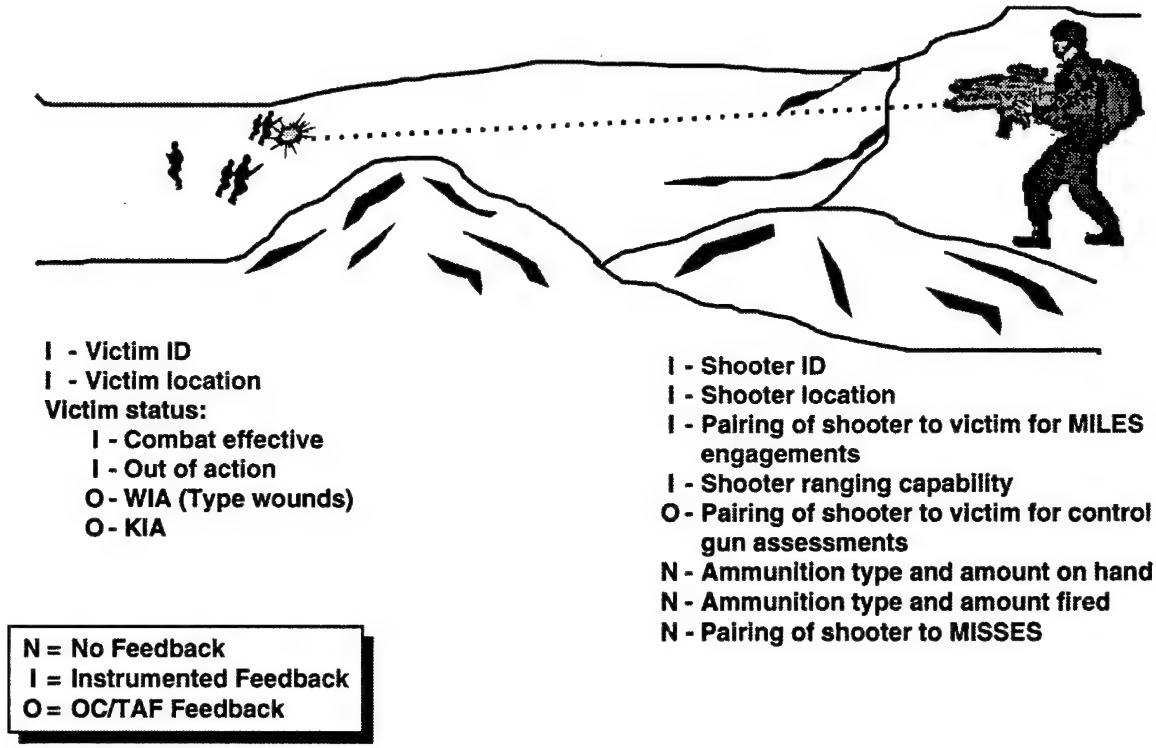


Figure 17. OICW extrinsic feedback requirements

MILES and the IS collect most of the extrinsic feedback data required to evaluate the system's employment (I). When the OC assesses casualties with his control gun, he records the reason for his assessment and pairs the shooter to the victim (O). The TES/IS cannot track the type and amount of ammunition on hand, or the type and amount of ammunition fired (N). This information is critical to assess the employment of the weapon since the firer may use either or both of two ammunition types to engage a target. The TES/IS provides neither the shooter nor the victim an indication of the point of impact for missed shots (N). The OC will check MILES casualty cards and record the status of each victim's status as WIA or KIA for MILES kills and control gun assessments (O).

OICW Data Collection Tasks

Figure 18 shows the OC and TAF analyst data collection tasks for the O-coded items in the previous figure.

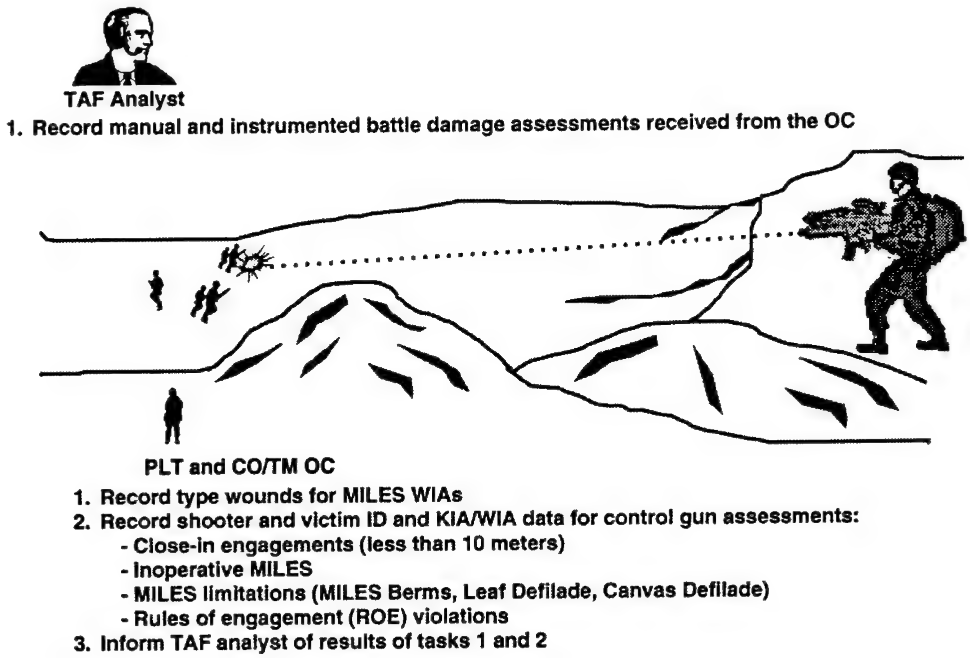


Figure 18. OICW extrinsic feedback tasks

The OC records the casualty assessments for all control gun assessments and forwards the information to the TAF analyst. The TAF analyst is the central collection point for all instrumented and manual casualty assessments.

Analysis Results for a Non-Lethal System

The following is an example of a non-lethal weapon system analysis--the High Power Acoustic Beam Weapon

Acoustic Beam Weapon Capabilities and Employment

The High Power Acoustic Beam Weapon enhances military unit operations in less than lethal situations. The weapon system can be mounted on vehicles and aircraft or be employed dismounted. Regulation of infrasonic audio and ultrasonic frequencies controls the intensity of the weapon's effects on personnel targets. Acoustic Beam Weapon effects vary from nausea, intestinal distress, organ damage, or even death. Weapon effects depend on range to the target, exposure time, and weapon

intensity settings. The acoustic beam can penetrate walls and affect personnel in buildings. The weapon is ideal in responding to hostage situations. Units may employ the weapon to support riot control and crowd dispersal operations in urban environments or in a perimeter defense role to protect secure areas (Faber, 1997).

Acoustic Beam Weapon Intrinsic Feedback Requirements

Figure 19 shows the intrinsic feedback required by soldiers during employment of the High Power Acoustic Beam Weapon.

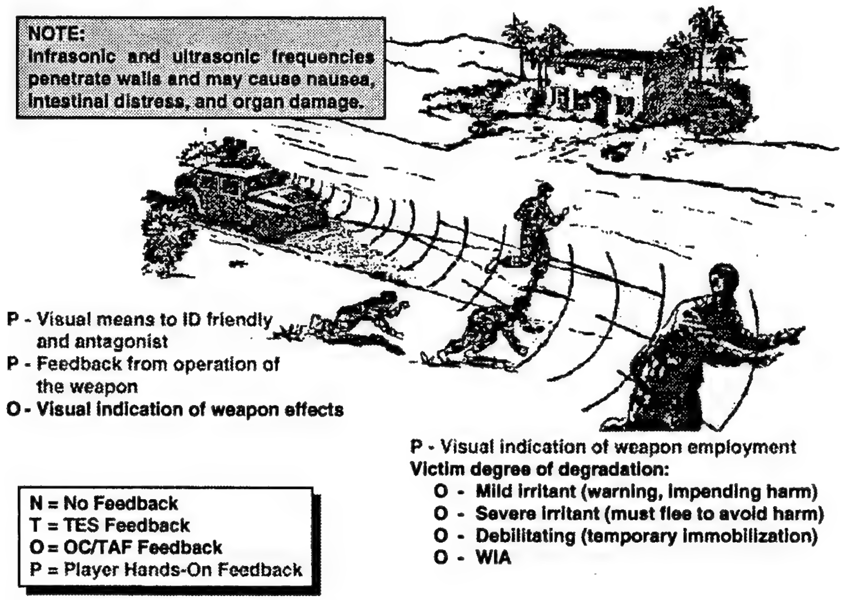


Figure 19. Acoustic Beam Weapon intrinsic feedback requirements

OPFOR or civilian role players provide the operator of the Acoustic Beam Weapon the ability to distinguish friendly from possible antagonist (P). The weapon operator receives intrinsic feedback from the operation and aiming of the weapon (P). The antagonists may receive a visual indication of the weapons employment by viewing the mounted or dismounted weapon move through the area. The current TES/IS cannot simulate the effects of the Acoustic Beam Weapon. Consequently, the OC provides the remainder of the required intrinsic feedback to the shooter and victim to simulate the engagement (O).

Acoustic Beam Weapon Control Tasks

Figure 20 lists the OC control tasks required to generate feedback on the O-coded items in the previous figure.

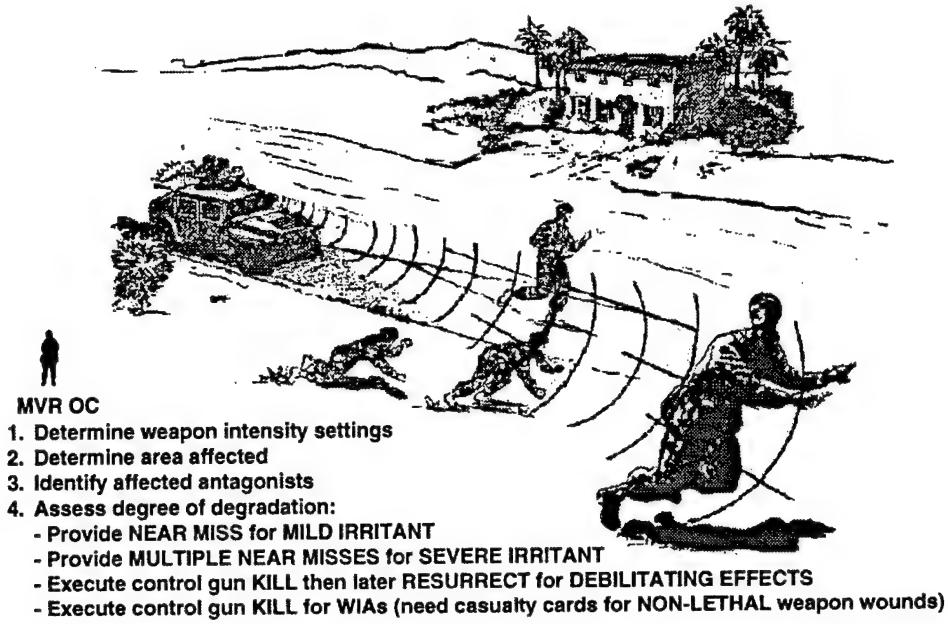


Figure 20. Acoustic Beam Weapon control tasks

OC control actions to support simulation of the High Power Acoustic Beam Weapon are intensive. The OC determines the intensity setting of the weapon and identifies the affected area. The OC then identifies the personnel affected by the weapon. For each victim he must simulate the effects the weapon would inflict on them using the control gun. If a victim is near the peripheral range of the beam, the OC will use his control gun to provide a near miss indication (mild irritant) to the victim(s). This warns them of impending harm from the weapon. For those victim(s) closer to the weapon the OC provides multiple near miss indications with the control gun. This informs the victim(s) they are in danger of being wounded (severe irritant) and must flee to avoid harm. Those victims very close to the weapon receive simulation of debilitating effects (temporary immobilization). To do this the OC uses the control gun to kill the victim(s) then resurrects them later. To simulate WIA, the OC uses the control gun to activate the player's MILES, and then the player activates his casualty card. New casualty cards are needed to reflect injuries associated with the non-lethal weapon. Intensive OC control actions are required to simulate the employment of the Acoustic Beam Weapon as well as other non-lethal weapons. Depending on the number of antagonists, control duties for the Acoustic Beam Weapon may overwhelm OCs.

Acoustic Beam Weapon Extrinsic Feedback Requirements

Figure 21 shows the extrinsic feedback data needed to evaluate the player's employment of the Acoustic Beam Weapon.

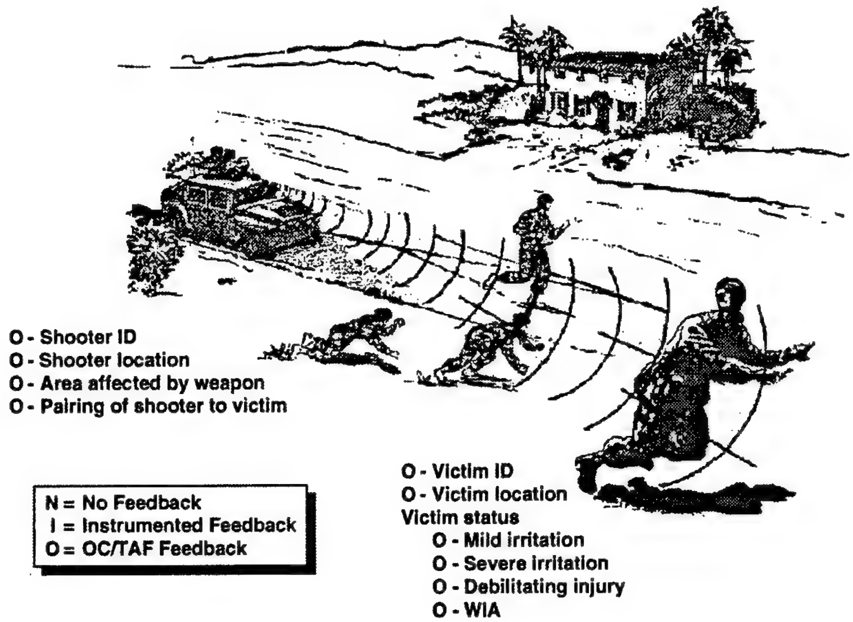


Figure 21. Acoustic Beam Weapon extrinsic feedback requirements

The OC collects all the information required for extrinsic feedback. By recording the results of his control actions (Figure 20), the OC captures the extrinsic data in Figure 21.

Acoustic Beam Weapon Data Collection Tasks

The OC's observations during the performance of his intrinsic control tasks will support the collection of extrinsic feedback data. The only additional thing the OC must do is record his observations and pass them to the TAF analyst for the preparation of AAR products.

Analysis Results for a RSTA System

We analyzed RSTA systems by identifying current and emerging systems organic to the Bn TF, under Bn TF control, or accessible by the Bn TF. We then identified the intrinsic and extrinsic feedback requirements of each system and contrasted these requirements with the current capabilities of TES and instrumentation systems. Finally, we determined the OC and TAF analyst control and data collection tasks necessary to satisfy the intrinsic and extrinsic feedback requirements. This section provides the results of our analysis for an example RSTA system--

the Maneuver Unmanned Aerial Vehicle (UAV). A detailed analysis of RSTA systems is in Appendix F.

Maneuver UAV Capabilities and Employment

The Maneuver UAV will provide reconnaissance, surveillance, and target acquisition support to the tactical ground forces within the maneuver brigade up to 30 km beyond the front line of troops. The system's capabilities will include day-night imagery and laser designation for an "over the hill" view of the battle area. The system is capable of both relay (operator) and autonomous flight control. Since the Maneuver UAV will be a maneuver brigade asset, we assume that the Bn TF will access the imagery and, at times, even control the employment of the UAV.

Maneuver UAV Intrinsic Feedback Requirements

During reconnaissance operations, the UAV operator plans the flight route, launches and flies the UAV, and acquires actual OPFOR entities. In Figure 22 the Maneuver UAV has located three OPFOR T72 tanks. The real-time imagery is fed back to the Ground Control Station (GCS). After visually identifying the three T72 tanks, the operator passes the targeting information to the Bn TF TOC. Operation of the real equipment and observation of the real-time imagery from the UAV provides all the intrinsic feedback the crew requires (P-coded items). There are no intrinsic feedback or control tasks for the OC or TAF analyst. During an exercise, if the OPFOR engages the UAV, the OPFOR receives no indication of the effectiveness of the simulated engagement (N-coded items).

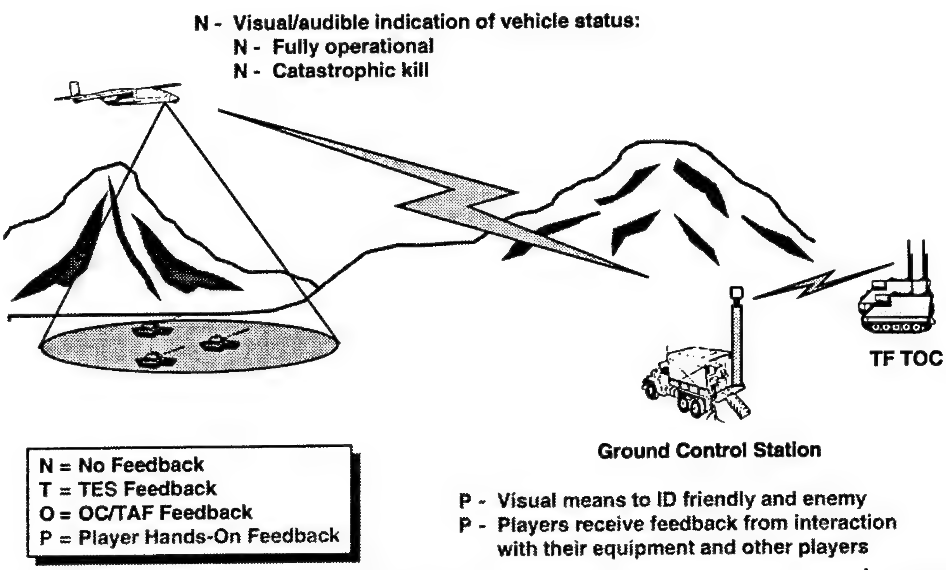


Figure 22. Maneuver UAV intrinsic feedback requirements

Maneuver UAV Extrinsic Feedback Requirements

To fully assess the Maneuver UAV's employment, the data shown in Figure 23 is required to construct AAR aids to illustrate the unit's strengths and weaknesses. Since there is no TES system for the UAV, the actual UAV flight path, imagery, operational status, and data on potentially acquirable targets (N) are not available. The flight plan, search areas/criteria, acquired targets, and actions taken on acquired targets (O) are available but require an OC to obtain them.

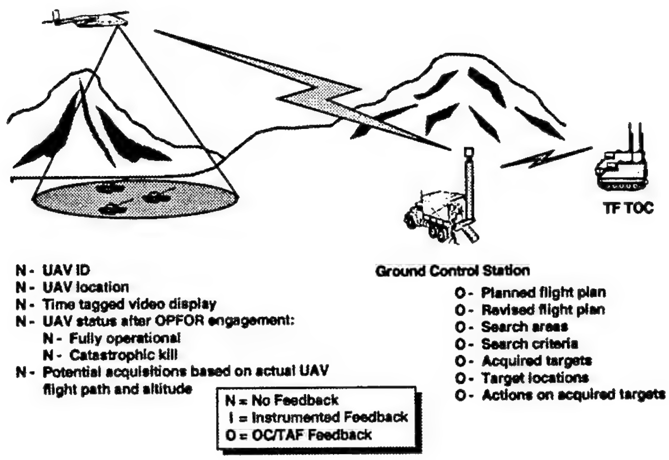


Figure 23. Maneuver UAV extrinsic feedback requirements

Maneuver UAV Extrinsic Feedback Tasks

Figure 24 below shows the extrinsic tasks for the Maneuver UAV. The TF S2 OC obtains the data shown in the previous figure and forwards the information to the S2 TAF analyst. The analyst records the information and constructs appropriate AAR aids.

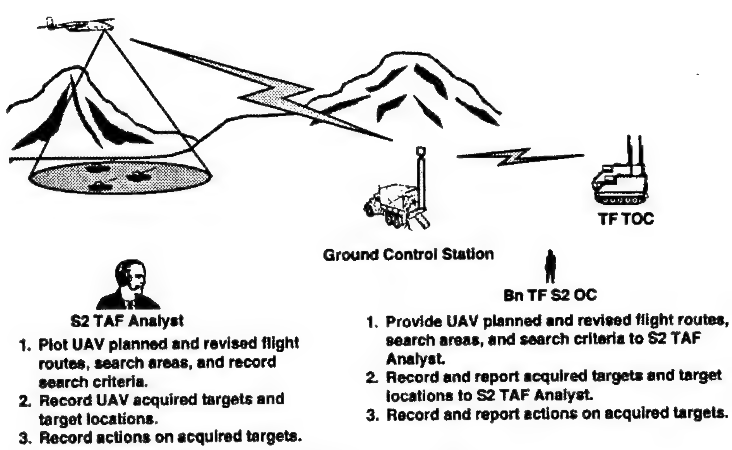


Figure 24. Maneuver UAV extrinsic feedback tasks

Analysis Results for C4I Systems

We focused our analysis on the Army Tactical Command and Control Systems (ATCCS) and Force XXI Battle Command Brigade and Below (FBCB2) formerly known as Appliqué. The ATCCS includes the five Battlefield Functional Area Control Systems (BFACS):

(1) Maneuver Control System (MCS)

(2) Advanced Field Artillery Tactical Data System (AFATDS)

(3) Forward Area Air Defense System for Command and Control (FAADS C2)

(4) All-Source Analysis System (ASAS)

(5) Combat Service Support Control system (CSSCS)

In addition, we studied the following ATCCS support systems to assess their impact on the ATCCS and FBCB2 systems:

(1) The Warfighter's Associate Terminal (WFA) which is part of the Global Broadcast System/Battlefield Awareness and Data Dissemination (GBS/BADD)

(2) Integrated Meteorological system (IMETS)

(3) Digital Topographic Support System (DTSS)

(4) Air Mission Planning System (AMPS)

This section provides an overview of C4I systems in general. It addresses OC, TAF analyst, and Exercise Management and Control Center (EMCC) intrinsic and extrinsic feedback tasks and IS limitations to provide the required feedback. The complete results of our C4I analysis are in Appendix H (C4I Systems Analysis) and Appendix I (C4I Systems Database).

C4I System Capabilities and Employment

ATCCS and FBCB2 provide common and specialized capabilities. The specialized capabilities are peculiar to the battlefield functional area (BFA) each C4I system supports. The BFAs are Maneuver, Fire Support, Intelligence/Electronic Warfare, Combat Service Support, and Air Defense. Capabilities that are generic across all BFACS include functionality such as:

- Command and control functions, mapping functions, information exchange, intelligence exchange, and resource management

- A common picture of the battlefield including friendly and enemy locations, control measures, and logistical and personnel reports

- Digitized terrain data and maps

- A client/server capability for the ATCCS and other C4I systems

- Interfaces with all ATCCS; many allied, joint, and other Army systems

- A messaging capability for the rapid exchange of C2 information

The ATCCS and FBCB2 systems are employed across the battlefield, literally from the fox-hole to the Pentagon. (See Appendix H for a complete list of the C4I systems we analyzed.)

Assumptions

Unless the CTCs are equipped with tactical digital systems, they cannot meet the intrinsic and extrinsic feedback requirements for digitized units. In our analysis, we assumed the EMCC, OCs, and TAF analysts were equipped with the appropriate digital systems to monitor all messages transmitted and received by their BLUFOR counterparts. We assumed that the EMCC also had the capability to transmit digital information to the rotating brigade. These assumptions permitted us to derive the manual exercise control and data collection tasks associated with battlefield digitization. However, we did not assume that the instrumentation system time-stamped and collected all C4I messages transmitted and received by BLUFOR players. Using this approach we identified a large number of manual tasks for the TAF analyst involving the transfer of information from the tactical C4I system into his instrumented workstation for presentation during the AAR. We discuss a strategy to reduce this workload later in the report.

C4I Intrinsic Feedback

BLUFOR players receive a large percentage of their intrinsic feedback from "hands-on" operation of their actual C4I systems

and from interactions with other digital systems. However, there are certain intrinsic feedback requirements that cannot be fulfilled without CTC assistance. CTCs must provide the Bn TF access to information sources that the TF could reasonably access in combat. There is also an intrinsic feedback requirement for the EMCC to play the role of the Division Tactical Operation Center (DTOC) or Joint Task Force (JTF) headquarters. As an exercise control function, the EMCC issues division or JTF operations orders, responds to rotational brigade requests for support from divisional or JTF assets, and simulates the role of other participants such as adjacent and supporting units. By meeting the C4I intrinsic feedback requirements for the rotational brigade, the EMCC, through the brigade, meets the intrinsic feedback requirements of the Bn TF. As the DTOC or JTF, the EMCC must have digitized connections to the rotating unit's C4I systems to play the role of higher, adjacent, and supporting units.

What information must be made available to the Bn TF? The player brigade ATCCS will provide the Bn TF access to historical and near-real-time data elements for all five BFAs. This will include information such as logistics reports, weather data, terrain data, intelligence data, enemy and friendly information, and decision support tools. However, exercise controllers in the EMCC role playing as DTOC or JTF headquarters must digitally feed the brigade ATCCS. Depending on the nature of the mission, the brigade and Bn TF could require access to GBS/BADD data up to the National Command Authority (NCA). Requested broadcasts could include weather, maps, satellite images, UAV data, intelligence, target information, and broadcast television. See Figure 25.

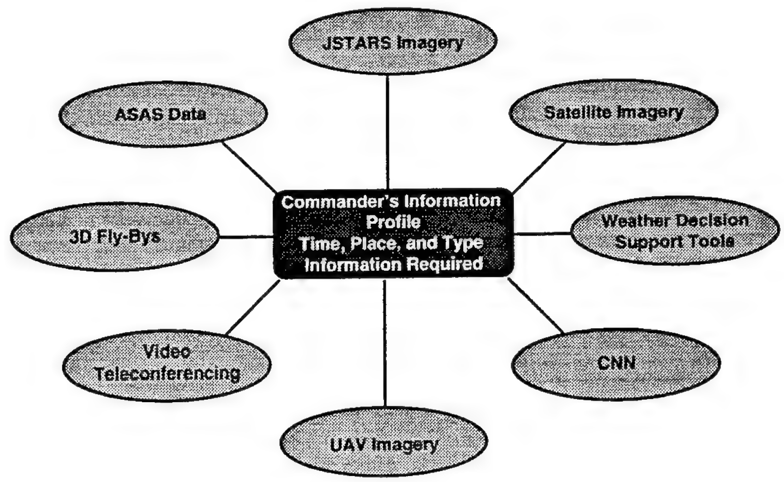


Figure 25. Example information available to commanders

Figure 26 illustrates some of the intrinsic requirements for the ATCCS. One of the most important aspects of C4I systems is

their interoperability and capability to access external information. While this capability is exciting and powerful, it has the potential to create complex exercise control requirements. Figure 26 depicts the need to role play higher, adjacent, and supporting units. It also points out intrinsic feedback requirements for higher intelligence, messaging capabilities, asset management, and connections to other C4I systems and sensors. The illustration also shows that it is not feasible for EMCC/DTOC/JTF personnel to "play" notional units down to the entity level. Because Bn TF exercise players receive intrinsic feedback from their interaction with C4I equipment and other players, there are no intrinsic control requirements for Bn TAF analysts.

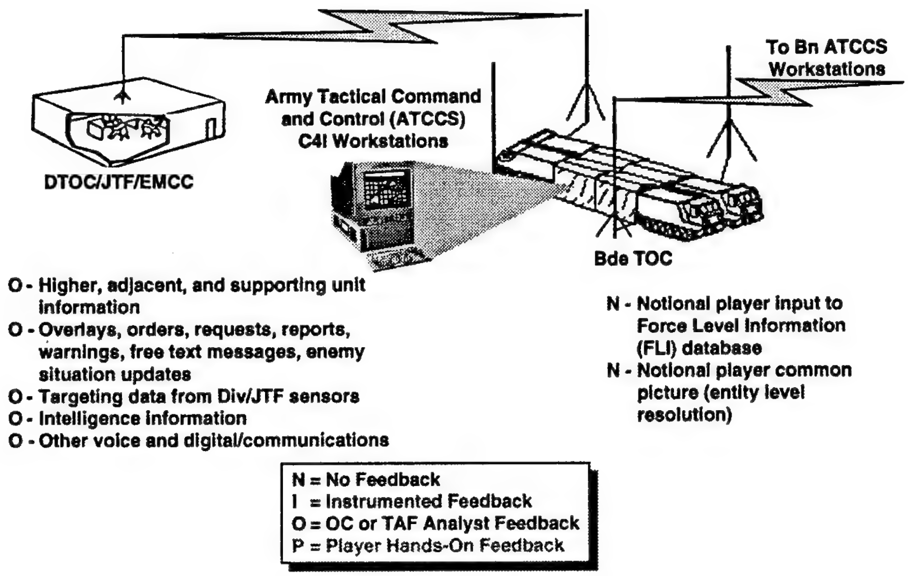


Figure 26. ATCCS intrinsic feedback requirements

The player brigade ATCCS will provide the Bn TF access to data elements for all five BFAs. However, exercise controllers in the EMCC role playing as DTOC or JTF headquarters must digitally feed the brigade ATCCS. For this reason we included the DTOC/JTF/EMCC in our analysis. The DTOC controller must role play higher, supporting, and adjacent units. He will send and receive voice and digital orders, overlays, reports, warnings, free text messages, intelligence, and requests. The DTOC controller will provide division or higher telestration. He will update unit task organizations as required. Our illustrations show DTOC controllers performing these tasks, but DTOC augmentees from the brigade's parent headquarters could also perform the tasks. If exercises employ DTOC augmentees, the DTOC controllers must still provide written orders and instructions through augmentees to provide BLUFOR players the needed intrinsic feedback. The Bn TF should be able to access information through

connections that will be in place if the unit actually deployed. This "smart push" and "warrior pull" of information will improve the realism of the exercise and maximize the training benefits of the CTC experience. See Figure 27.

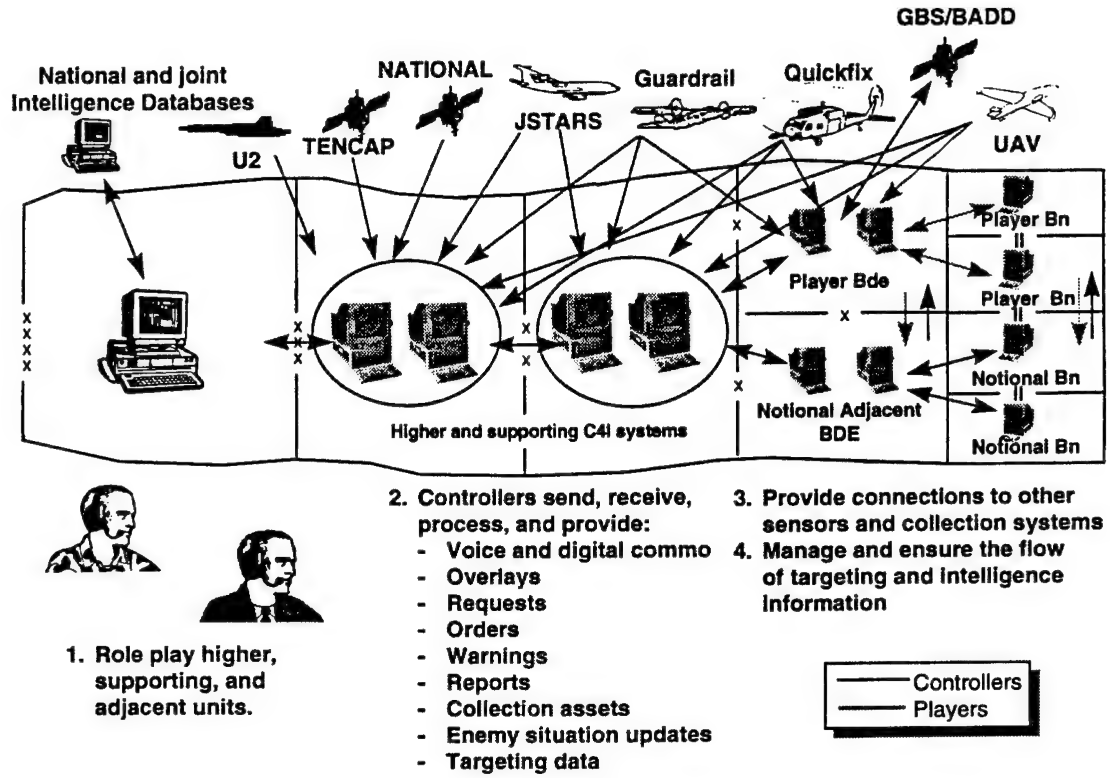


Figure 27. DTOC/JTF/EMCC C4I intrinsic feedback tasks

C4I Extrinsic Feedback

The good news about battlefield digitization is that there is a great deal of available data for the OC and TAF analyst to examine to determine the cause and effects that led to specific battle outcomes.

The Army Research Institute (ARI) maintains a database that identifies what data elements the trainer needs to assess whether or not a unit performed a specific task to standard. The database focuses on the virtual environment but is still illustrative of the impact of digital communications on unit performance assessment. The database contains over 5000 Mission Training Plan (MTP) standards for the tank platoon, company team, and Bn TF. The database indicates the types of data needed to assess the unit's performance (Meliza, 1993):

A -- Network data (electronically collected data, i.e.,

vehicle location)

C -- Radio communications

O -- Direct observations of leaders and soldier behaviors

P -- Planning product (i.e., orders and overlays)

T -- Terrain information

Generally, a trainer must apply a mix of data types to determine if a unit achieved the standard. For example, in the tank platoon standard "platoon occupies position designated in OPORD and moves to turret down position," the trainer assesses the platoon's performance using:

- A-coded data (electronically collected data, i.e., position of the vehicles)
- P-coded data (i.e., overlay designating platoon positions)
- T-coded data (i.e., the lay of the terrain)

A re-examination of the database considering digital terrain data, digital communications, and digital planning products reveals that trainers can assess performance using more A-coded (electronically collected data). For terrain related standards, the trainer can assess 16 percent of the standards using A-coded data. For those standards related to radio communications, the trainer can assess 58 percent of the standards based on use of digital communications by the players. Fifty-eight percent is an overestimate since units resort to voice communications upon contact with the enemy. There are other factors which would cause voice or courier to prevail over digital--intervening terrain, state of training, and the tactical situation. For standards related to planning products, the trainer can assess 32 percent of the standards using digitized operations orders, overlays, etc. Digital communications will provide electronic data points for training assessment where there were none before.

The following C4I illustrations identify the sources of extrinsic feedback: Instrumentation System (IS), OC/TAF analyst, and extrinsic feedback not attainable. Recall that we assumed all TAF analysts are equipped with the appropriate digital systems to monitor all messages transmitted and received by their BLUFOR counterparts.

Figure 28 reveals that the only instrumented C4I data available is BLUFOR voice communications and entity ground truth

dispositions. The great majority of the information needed to assess C4I performance is not available through the IS. This situation creates manually intensive procedures for the TAF analyst. He must manually transfer information from the tactical digital system to the AAR workstation to develop C4I AAR products.

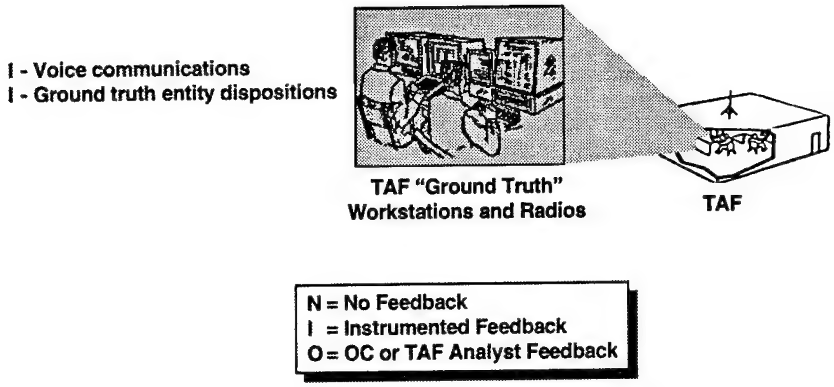


Figure 28. C4I instrumented extrinsic feedback

Figure 29 illustrates TAF analyst and OC requirements for extrinsic feedback data. In general, TAF analysts are concerned with data collection and analysis, and OCs are concerned with player behavior (information that is not available in the IS data stream).

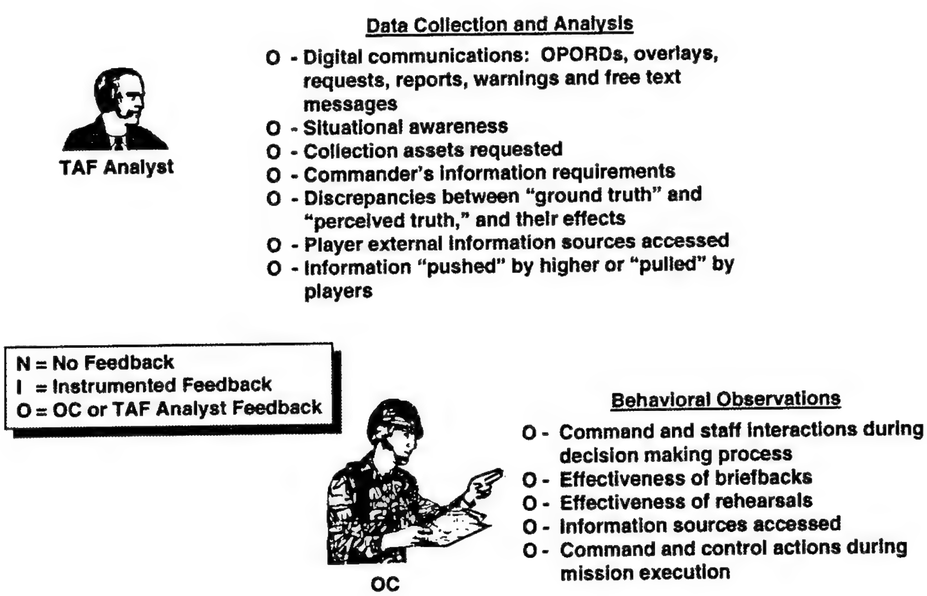
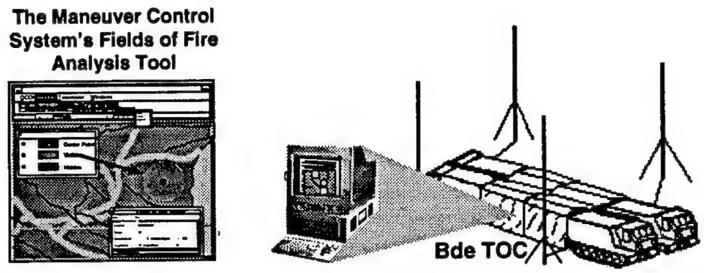


Figure 29. OC and TAF analyst C4I extrinsic feedback requirements

Determining precisely what the ATTCS or FBCB2 operator is viewing at any given time could be valuable to the TAF analyst.

However, it is not feasible for the IS to identify the exact information the operator is viewing on his C4I system. TAF analysts will not know which display options an operator selected nor which system decision support tools the operator used. Further it is impossible to determine from instrumented data what cognitive processes the operator performed on the information received. Did the operator actually read the message or did he just press the button that turns off the message alarm? See Figure 30.



N - Player actions and inactions on received information and decision support products
N - Decision support tools used, i.e.
- Integrated Weather Effects Data Analyzer (IWEDA)
- Terrain enemy movement analyzer
- Sensor placement tools
- Electronic line-of-sight tools
- Terrain analysis tools.
N - ATCCS is not integrated with current instrumentation system for collection of digital data.

N = No Feedback
I = Instrumented Feedback
O = OC or TAF Analyst Feedback

Figure 30. Unattainable C4I extrinsic feedback

Determining which decision support tool the operator used, what messages he read, and how he used acquired information cannot be captured unless an OC continually observes the operator's activity. OC manning limitations will not permit this. The AAR may become the means by which OCs learn the decision support information BLUFOR consulted and how the players used the information. The best approach may be to identify the performance problem, then retrieve information available to the BLUFOR that impacted on the problem. During the AAR the OC may ask members of the AAR audience what decision support tools they used, who they informed of their findings, and what information proved useful in generating courses of action and arriving at a decision. With the overwhelming amount of information available to units, the major job for OCs and TAF analysts is to show units what their critical C4I information needs are for the planning, preparation, execution, and reconstitution phases of a tactical operation.

<u>OC C4I Extrinsic Feedback Tasks</u>. The OC observes staff appraisals and makes assessments about the process used to

develop and select courses of action. The OC observes and records who attends briefbacks, the perceived understanding of the plan, and the production and dissemination of changes to the plan. The OC observes and records the rehearsal type, the rehearsal process, and the participants' understanding of the plan and changes to the plan. For a summary of OC C4I tasks, see Figure 31.

1. **Observes and assesses staff procedures, war gaming, IPB process, and personnel interactions.**
2. **Observes and assesses course of action development/selection and intelligence processing procedures.**
3. **Observes and assesses orders preparation, briefbacks, rehearsals, and mission execution.**
4. **Informs TAF analyst of all observations.**

Figure 31. OC extrinsic feedback tasks

<u>TAF Analyst C4I Extrinsic Feedback Tasks.</u> The TAF analyst reviews OPORDs, overlays, FRAGOs, requests, reports, free text messages, and warnings and transfers key digital information from his ATCCS or FBCB2 system to his instrumented workstation. The analyst records key points made in all telestrations. He enters revisions to the player unit task organization into his instrumented workstation. In coordination with his counterpart OC, he identifies and records discrepancies between "ground truth" (instrumented data) and "perceived truth" (ATCCS/FBCB2 data), and the effects of these disparities. Identifying the disparities between these two "truths" may provide insights into the causes of battle outcome. Finally, the TAF analyst builds multimedia C4I AAR products in coordination with his counterpart OC. Figure 32 summarizes TAF analyst C4I tasks.

1. **Transfers key digital information from ATCCS/FBCB2 into the instrumented workstation, to include:**
   - a. **Digital communications.**
   - b. **Situational awareness and analysis.**
   - c. **Overlays/Templates.**
   - d. **Reports.**
   - e. **Warnings.**
   - f. **Free text messages.**
   - g. **Requests.**
   - h. **Collection assets requested.**
   - i. **Commander's information requirements.**
2. **Records player access to external information sources.**
3. **Crosswalks the mission information requirements to the information "pulled" by players and "pushed" by higher.**
4. **Annotates discrepancies between "ground truth" and "perceived truth," and their effects.**
5. **Crosswalks the maneuver commander's scheme of maneuver with the fire support plan, air defense plan, intelligence plan, etc.**
6. **Builds C4I AAR products.**

Figure 32. TAF analyst extrinsic feedback tasks

C4I IS Limitations

OCs and TAF analysts at the Maneuver CTCs have the capability to eavesdrop on voice communications during the exercise. The TAF has the capability to record, time stamp, and playback voice communications on all BLUFOR tactical nets to support AAR presentations. However, the CTCs do not have digital systems to support exercise control requirements nor training analysis and feedback requirements. The move to digital communications with systems like the FBCB2 will require OCs to look directly over the shoulders of their counterpart to observe messages being sent and received, unless interventions can be provided to support a less obtrusive means of monitoring these communications. Today, TAF analysts cannot eavesdrop on player C4I digital communications to view BLUFOR plans, reports, and situational awareness. The EMCC cannot insert digital message traffic into the exercise to role play non-playing higher, adjacent, and supporting units.

Equipping OCs and TAF analysts with BLUFOR digital systems is not sufficient. The information generated by BLUFOR digital systems is overwhelming. OCs and TAF analysts need an automated capability that alerts them to significant BLUFOR digital actions or inactions. This capability permits OCs and TAF analysts to focus on the cause and effect relationships of critical digital C4I communications.

AAR Preparation Tasks

The extrinsic feedback data we derived for each emerging combat system supported assessment of each system's performance during the exercise. However, AARs do not focus on each combat system's performance. AAR products address the unit's performance in each battlefield operating system (BOS). Each of the seven BOSs orient on the performance of multiple collective tasks. In the next step of our analysis, we identified a representative task in each BOS to analyze the tasks involved in the preparation of AAR displays or aids. This analysis allowed us to test the combat system extrinsic data for completeness and to gain insights into strategies to reduce OC and TAF analyst workload during AAR preparations.

NOTES:

Army Tactical Systems (ARTs) is the new term for BOS. During the course of the study, however, we found that even recent documentation rarely used the new term. We use the term BOS since most readers are familiar with the older term.

During our visits to CTCs, we found that the emphasis for AAR preparations is on supporting the Bn TF AAR, then BOS AARs, then lower echelon AARs. Co and Plt OCs often conduct AARs from the hoods of their vehicles and may or may not use TAF AAR products. Whether the OC receives TAF-prepared AAR aids depends on the OC's desires and if the TAF has sufficient time available to construct Co and Plt AAR aids during Bn TF AAR preparations.

Methodology

To gain an understanding of specific tasks the OC and TAF analyst must perform to construct AAR aids, we conducted an analysis of the AAR aids required to support representative collective tasks. See Figure 33. First, we selected a representative task for each BOS from the Center for Army Lessons Learned (CALL) quarterly Maneuver CTC trends publication. We selected tasks assessed by CALL as "needs emphasis" to ensure that we focused on tasks OCs typically address during CTC AARs. Next we identified the type of AAR aids required to support AAR discussions for each task and illustrated each aid. See Appendix J for definitions of the various AAR aid types and the illustrations we developed to depict BLUFOR performance.

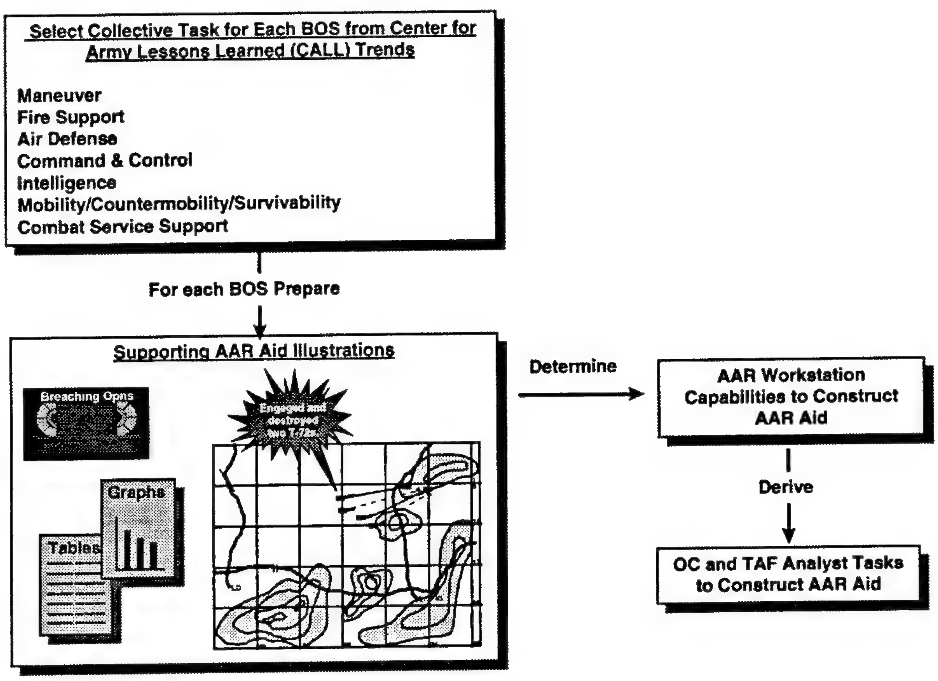


Figure 33. Identify AAR aids for representative BOS tasks

Based on the aid type and our illustrations of each aid's content, we identified the actions/tasks required to construct the AAR aid, for example:

(1) Identify the moment of initial contact by the scout platoon.

(2) Slew the exercise clock back in time to the moment of initial contact.

(3) Pan the map to the location of the contact.

(4) Enable display of BLUFOR maneuver graphics and OPFOR and BLUFOR entities.

(5) Time-tag the scout platoon leader's spot report to the TF commander for play back.

(6) Annotate any discrepancies between the platoon leader's spot report and actual OPFOR dispositions.

Finally, we identified which tasks the AAR workstation (a component of the instrumentation system) performed and those tasks left to the TAF analyst or OC to perform. See Appendix J (AAR Preparation Tasks by BOS).

Impact on OC and TAF Analyst Workload

For AAR preparations, OC's are especially effective in collecting and reporting behavioral observations, i.e., interaction among the commander and staff during the decision making process, brief backs by subordinate commanders, and conduct of mission rehearsals. To support the preparation of AAR products, OCs collect orders and overlays from BLUFOR and ensure the timely delivery of these items to the TAF. OCs also record and report significant tactical events, BDA, and information pertinent to effectiveness of BLUFOR's reconstitution efforts. At the end of the exercise, OCs review their observations, group their observations into key issues for discussion, then link the key issues to doctrine and battle outcome.

The TAF analyst is responsible for the production of a mix of multimedia AAR aids that maximize post-exercise discussion and learning. (See Appendix J for various AAR aid types.) The analyst prepares specific aids based on the key teaching points the OC wishes to make during the AAR. The analyst participates in the AAR rehearsal (for Bn TF and support slice AARs) and revises, deletes, and builds additional aids as directed by the

senior OC. Finally, the TAF analyst integrates and sequences the presentation of all AAR products.

In our analysis, we identified a total of 25 OC and 86 TAF analyst AAR preparation tasks based on a limited sample of one tactical task for each BOS. Undoubtedly, analysis of additional BOS tasks will yield many more AAR preparation tasks. However, the analysis clearly shows that OCs are involved in data collection tasks which divert them from player behavioral observations, coaching, and mentoring. The TAF analyst clearly has the burden of constructing numerous AAR products considering a wide range of media during the short time-frame between exercise end of mission and the senior OC's AAR rehearsal.

Although TAF analysts create numerous aids during the planning, preparation, and execution phases of the battle, the AAR products may or may not be useful for the AAR. The factor driving the selection of which aids will be presented is battle outcome. However, since neither the OC nor the TAF analyst can positively predict battle outcome and the primary causes and effects that led to that outcome, the TAF analyst must generate AAR aids during the exercise for any eventuality. There is no tool to assist the OC or TAF analyst select which AAR aids are pertinent based on the battle outcome. There are no sets of standard AAR products linked to battle outcome by BOS which use the best medium or combination of media to stimulate AAR audience discussion, self-assessment, and fixes. Consequently, much time is wasted reviewing numerous AAR aids that are not pertinent for the AAR. We developed the AAR aids in Appendix J to identify AAR preparation tasks. The aids also illustrate the utility of linking standard sets of AAR aids to OC subjective judgments on the causes which contributed to battle outcome.

It is also apparent that TAF AAR preparations are manually intensive. The TAF analyst must be highly skilled in the operation of a complex AAR system and tactically and technically competent in the mission executed by the exercise players. The TAF analyst builds each AAR aid from scratch, one aid at a time. With the advent of battlefield digitization, the AAR system will become even more complex, demand additional skills, and result in the generation of a greater number of AAR products to review for pertinence. This will be highly difficult for the trained CTC analyst to cope with and impractical for the Home-station Training Instrumentation operator.

Other OC Tasks

From our visits to CTCs, it became apparent that OCs perform a host of duties that are not evident from an analysis of

intrinsic and extrinsic feedback requirements for emerging systems or from an analysis of AAR and THP preparations.

OCs also perform the following duties:

(1) Coach and mentor their player counterparts during mission planning and preparation phases and exercise pauses.

(2) Develop an observation and control plan before each exercise to preclude overlooked or uncontrolled events and compromise of BLUFOR or OPFOR dispositions.

(3) Prepare routine risk assessments and cross-check their assessments with their BLUFOR counterpart, proactively identifying safety issues and recommending measures to reduce risk.

(4) Coordinate with OPFOR on major planned actions and small unit attacks against BLUFOR TOCs, unit trains, and assembly areas.

(5) Submit numerous pre-formatted reports to their senior OC or TAF counterpart.

(6) Investigate and report how and why fratricides occurred.

(7) Make detailed observation notes.

(8) Link observations to key issues (teaching points).

(9) Identify issues which most affected battle outcome.

(10) Coordinate key issues with OPFOR to ensure consistency during the AAR.

(11) Link key issues to exercise objectives and military doctrine.

(12) Coordinate and assist linkup and pickup of abandoned enemy prisoners of war and casualties.

(13) Brief BLUFOR players and CTC visitors.

(14) Formally train Army Readiness Region OCs to support Reserve Component training.

(15) Formally train augmentation OCs from nonplayer units and the US Army Training and Doctrine Command (TRADOC)

schools to meet OC requirements that cannot be met by assigned CTC personnel (i.e., OC augmentation to observe and control UAV ground control station operations).

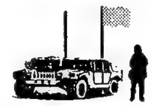
(16) Prepare "how to" videotapes on tactics, techniques, and procedures as part of the trends reversal process for selected training weaknesses observed over numerous CTC rotations.

(17) Author "how to" magazine articles for the Center for Army Lessons Learned (CALL).

(18) Host BOS conferences.

(19) Respond to TRADOC school training and combat development questions and surveys.

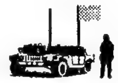
OCs must transport a large library of references to perform the tasks outlined above. See Figure 34. Ensuring all OCs have a <u>current</u> reference library requires a considerable effort by the OC team's senior leadership. Manual searches for information in paper-based references is terribly time-consuming and often results in an incomplete search. OCs need a capability to rapidly locate information under adverse field conditions (cold and dark) to perform their duties.



- **Standard Operating Procedures (SOPs)**
  - **Operations Group SOP**
  - **OC Team SOP**
  - **TAF SOP**
  - **Player Unit SOP**
- **Rules of Engagements (ROE)**
- **Tactics, Techniques, and Procedures (TTP) Manuals**
- **ARTEP-MTP Training and Evaluation Outlines (TEOs)**
- **Coaching Aids**
- **Operator Level Technical Manuals**
  - **Player Unit Equipment**
  - **OC Equipment**
  - **MILES**
- **Briefings**
- **Checklists**

Figure 34. OC references

There are numerous recurring, pre-formatted reports that OCs submit to their senior OC or a TAF analyst. Figure 35 provides a sampling of reports we found in the JRTC OC handbook and from our interviews with OCs during visits to JRTC and CMTC. After finding the desired report in the appropriate standard operating procedure (SOP) or in a compilation of reports collected from several SOPs, the OC hand-writes the report and/or submits the report orally over a control net. The receiver of the report (another OC or TAF analyst) records the information by hand. On occasions, the nature of the report may require the OC to travel to the addressee's location to deliver the report. In any case, preparation and submission of reports is a manually-intensive activity which detracts from the OC's ability to observe, coach, and mentor his BLUFOR counterpart.



- Observation and Control Plan
- Risk Assessments
- Unit Location/SITREP
- Unit Movement
- Unit Occupation
- Player Contact
- BDA
- Control Gun Assessments
- Fratricide
- Activity Timelines
- Observations
- AAR Key Issues
- Unit Headcount
- Unit Equipment Status
- Unit Ammo Status
- Use of Chemical Agents
- Terrorist Activity
- Player Contact with Civilians
- Rules of Engagement Violations
- Rules of Engagement Suggestions
- Enemy Prisoner of War
- War Crimes
- Wrap-up Reports
- Trends for CALL
- Downed UAV
- Mishap
- Cease Jamming
- Sensitive Items
- Unrecovered Sensor
- Requests:
    - MEDEVAC
    - MILES Contact Team
    - BDA Assessment

Figure 35. OC reports

Observations of human behavior and coaching may require the OC to separate himself from his vehicle and controller communications. This presents a dilemma for the OC. If the OC is unable to hear others calling him on the radio, his absence from the control net may impact adversely on the control of a critical exercise activity. If he stays with his vehicle to respond to radio calls, he may miss an observation or coaching opportunity; i.e., generation of courses of action by the Bn TF staff within the BLUFOR tactical operations center (TOC). When the OC judges that exercise control is the dominant factor, he remains with his vehicle. JRTC OCs use a commercial radio they refer to as the Observer Controller Communications System (OCCS). The OCCS is a hand-carried radio that OCs may use with or without earphones and a mike boom. The radio permits the OC to move about freely dismounted or mounted and remain in continuous communications with other OCs.

Preparing detailed observations, translating observations into key issues, and linking key issues to exercise objectives and military doctrine are intensive and highly time-consuming tasks. An OC must have considerable experience, tactical and technical knowledge, and organizational ability to perform these tasks successfully.

Take Home Package (THP) Preparation Tasks

The CTCs provide a THP at the conclusion of a unit's training cycle/rotation. The unit uses the THP to assess its training status for each task listed in their Mission Essential

Task List (METL) and to develop near- and far-term training plans to sustain acquired skills and to correct training weaknesses identified during the rotation.

To determine specific tasks the OC and TAF analyst perform to construct THPs, we visited two CTCs. Figure 36 depicts our findings.

THP COMPONENT	RESPONSIBLE
Written Report	
• Rotation Executive Summary	Sr. OC
• Mission Summaries	
Battle Summary	Sr. OC
Unit Mission	TAF Analyst
Unit Commander's Intent	TAF Analyst
BLUFOR Combat Losses	TAF Analyst
OPFOR Combat Losses	TAF Analyst
Fratricides (if any)	TAF Analyst
• BOS Summaries by Mission	OCs
• CO/TM Summaries by Mission	OCs
Formal AAR Video Tapes	Audio/Visual Facility

There is a move toward smaller THPs at CMTC and JRTC:

- Issues
- Three strengths
- Three weaknesses

Figure 36. THP components

Within the written report we identified four primary components: the Rotation Executive Summary, Mission Summaries for each mission during the rotation, BOS Summaries by Mission, and CO/TM Summaries by Mission.

The Sr. OC provides the written executive summary that encapsulates the unit's performance during the rotation. The executive summary may contain comments on all or part of the following:

- General information about the unit's training cycle/rotation
- Commander training
- Staff training
- Unit training
- Individual BOS areas
- Overall strengths
- Training areas requiring emphasis
- Overall training status at the conclusion of the rotation
- Recommendations

Each mission summary consists of a battle summary and standard AAR mission slides. The Sr. OC provides the battle summary. The battle summary provides a synthesis of the mission from beginning to end, identifying key points in the battle and their impact on the final outcome. A TAF analyst provides AAR slides which may include any or all of the following, as appropriate:

- Unit mission
- Commander's intent
- BLUFOR combat losses
- OPFOR combat losses
- Strengths
- Weaknesses
- BOS material
- Fratricides, if any, that occurred

The OCs provide written mission summaries for each of the seven battlefield operating systems (BOS) and for each Co Tm. Their comments are oriented on mission planning, preparation, and execution. The summaries emphasize strengths, weaknesses, and areas needing improvement.

As previously stated, a key element of the THP is the formal AAR video tape for each mission. Each AAR video tape provides the unit an archive of the dynamic discussion among the BLUFOR exercise players following a mission in which the key leadership of the unit strived to determine: "What happened," "Why it happened," and "How to improve performance." The video captures the OC as he guides player discussions to establish the causes and effects that led to the outcome of the battle. It also captures all AAR aids (computer-generated imagery, audio clips of tactical communications, statistical tables and graphs, and video) presented during the AAR.

Figure 37 shows the associated tasks identified for each OC and TAF analyst to prepare the THP.

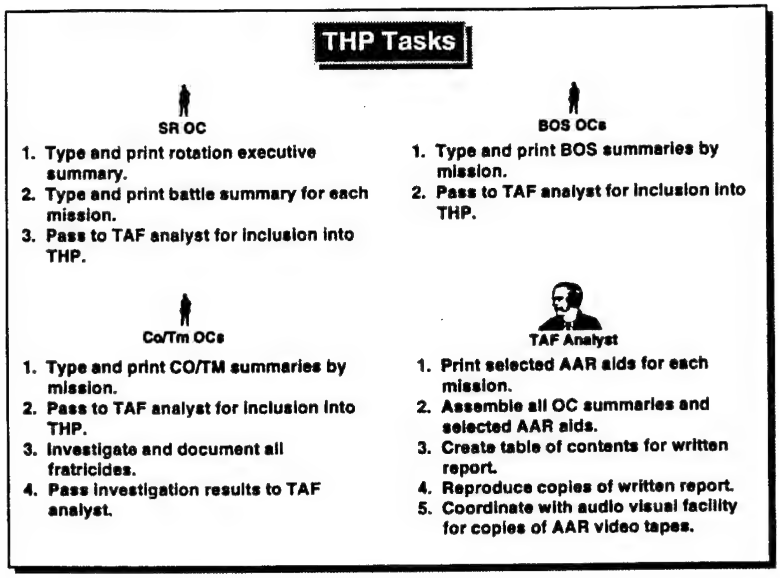


Figure 37. THP tasks

We assume that each OC will either have access to a computer and printer for his use in typing his respective summaries or will have dedicated support to transcribe his hand written notes.

Upon departure, or soon after departure from the training site, rotating units receive a multimedia THP—which, in some cases, may be large enough to fill a footlocker. There is a move at JRTC and CMTC to reduce the size of the THP and to focus on key issues. For example, at JRTC the OCs prepare a one page assessment for the Bn TF and a one page assessment for each subordinate and supporting unit. Each assessment addresses the key issues that surfaced during the unit's rotation and points out three unit strengths and three training weaknesses. OCs also prepare similar one page assessments for each BOS.

Strategies to Reduce Workload

In this section of the report we provide an overview of tactical engagement simulation (TES) systems and instrumentation system (IS) capabilities today. We discuss strategies to reduce the burden on OCs and TAF analysts in performing tasks involving exercise control, data collection, AAR preparations, coordination and mentoring, and THP construction. The strategies describe operational concepts but do not offer technical solutions. The study is not a Manpower, Personnel, and Integration (MANPRINT) effort. We have not analyzed task criticality, complexity, duration, or repetitions for the OC and TAF analysts tasks identified in this study.

Today's Tactical Engagement Simulation and Instrumentation Systems

The Simulated Area Weapons Effects/Multiple Integrated Laser Engagement System II (SAWE/MILES II) is the primary tactical engagement simulation (TES) system that provides battlefield effects for live, force-on-force training. MILES II simulates the effects of direct fire engagements using eye-safe laser transmitters. SAWE simulates indirect fire, nuclear, chemical, and mine effects using controller actions and instrumentation towers to assess area weapon effects. MILES II requires minimal exercise control, but the fidelity of direct fire, line of sight (LOS) simulation is limited by laser technology.

For LOS engagements, the visual and audio cues produced by pyrotechnics on the firing vehicle create a signature for acquisition by the targeted vehicle. When killed, the target vehicle's MILES II actuates a continuous, blinking amber light informing the crew that their vehicle is out of action and notifying the firing crew that they destroyed the target vehicle.

MILES II has fidelity limitations which cause OCs to perform exercise control actions. MILES lasers will not penetrate minor obstructions. Tree leaves ("tree-leaf defilade") will obstruct the laser. Firing positions with berms ("MILES berms") that are inadequate to stop penetration by real ordnance will stop a MILES laser beam. Smoke and dust degrades the effectiveness of the laser and may preclude engagements at maximum range. For safety, JRTC rules of engagement preclude the use of MILES by dismounted soldiers for close-in engagements at less than 10 meters. OCs manually perform exercise control using laser pistols (control guns) in those instances where MILES fidelity limitations or safety preclude automatic casualty and battle damage assessments.

Although the shooter receives intrinsic feedback when he hits a vehicle (continuous, blinking amber light on the target vehicle), the feedback he receives when he misses the target is inadequate. If he near misses the target, the amber light will blink two or three times. If he misses the target by a considerable distance, the amber light on the target vehicle does not blink at all. For misses, the shooter receives no feedback to sense whether the ordnance fell short, long, left, or right of the target. Data collection does not pair the impact location of missing rounds to the firer for purposes of extrinsic feedback. See Figure 38 for MILES II limitations.

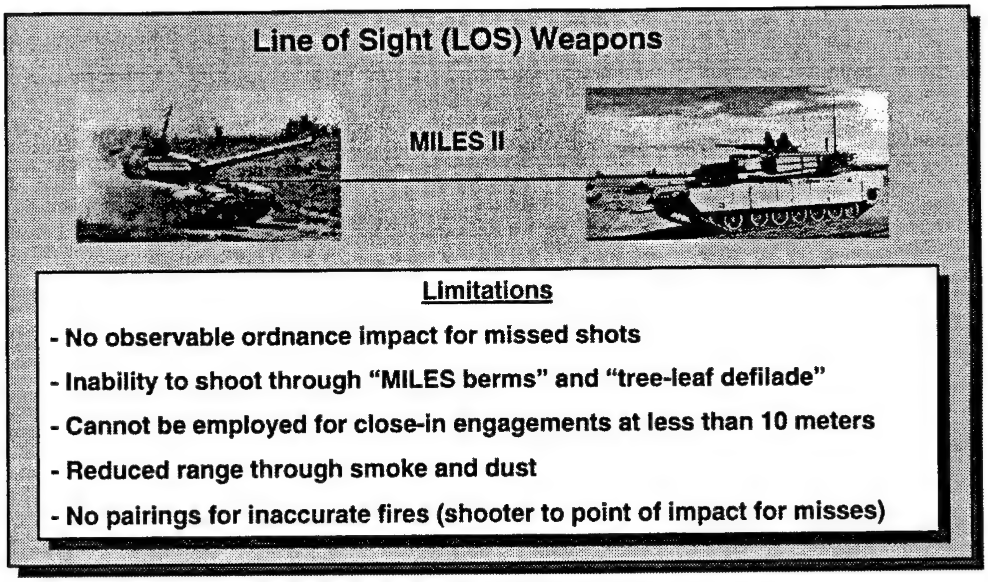


Figure 38. Limitations of laser-based technology

SAWE produces visual and audio cues and assesses battle damage and casualties for non-line of sight (NLOS) area effects weapons. For indirect fire resulting in a near miss, hit, or kill, SAWE sets off pyrotechnics in vehicle-mounted Audio-Visual Devices (AVDs) creating flash, bang, and smoke signatures. The blinking amber light indicates a near miss or kill just as in LOS engagements. For indirect fires against dismounted soldiers, a firemarker provides the visual and audio cues to simulate impacting ordinance. SAWE assesses personnel casualties by activating the audio alarm on the soldier's Man Worn Laser Detector (MWLD).

Unlike LOS engagements, NLOS engagements require intensive manning and control actions to produce the simulated effects. After extensive OC and TAF analyst coordination and considerable manual input into the SAWE control station, SAWE performs battle damage assessment (BDA) based on the munition type, volume, and accuracy of fires.

For inaccurate indirect fires impacting well beyond OPFOR vehicles that SAWE cannot mark using vehicle AVDs, a firemarker marks the impacting ordnance. Firemarkers also mark fires against dismounted soldiers. Firemarkers equipped with smoke generators or smoke pots produce the smoke for artillery and mortar smoke missions. Firemarkers use flares to simulate illumination produced by indirect fire units. Firemarkers may not be timely in marking fires because of the distance to the target, terrain, and visibility conditions (day or night).

Unless the OC detects obvious gunnery errors by the mortar or artillery fire direction center (FDC) or by the mortar or howitzer crews, the grid in the call for fire is the location marked and assessed for casualties and battle damage. For undetected gunnery errors, the errors are not projected down range during force-on-force training. See Figure 39 for SAWE limitations.

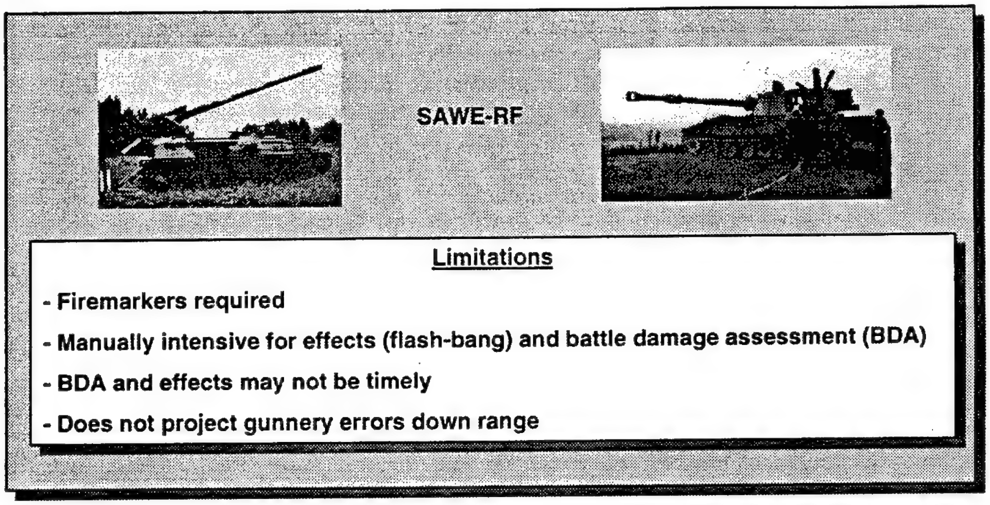


Figure 39. SAWE limitations

TAF analysts use SAWE to execute and assess OPFOR fires on BLUFOR for notional OPFOR artillery. SAWE also supports casualty assessments for chemical and nuclear attacks. For chemical attacks, the Player Detection Device (PDD) senses whether or not a soldier has properly sealed his protective mask. If the seal is not air tight or the player breaks the seal in a chemically-contaminated environment, SAWE kills the player through his MWLD.

Strategy 1 - Automate NLOS BDA

Simulation modeling has the potential to reduce OC and TAF analyst control and data collection tasks substantially for NLOS engagements and, as a byproduct, improve the fidelity and extrinsic feedback of indirect fire simulations. However, simulation modeling is not a feasible option today for solving some of the LOS engagement limitations we have addressed. We will explain why later.

Providing an NLOS simulation modeling capability requires installation of sensors on actual indirect fire platforms to determine tube azimuth/elevation and the type ammunition fired. In this strategy the NLOS simulation model receives data from indirect fire platform sensors and computes the "should hit" projectile location. Using the "should hit" location, ammunition

type, and volume of fires, the NLOS TES system cues the activation of pyrotechnics in AVD-equipped vehicles and calculates and executes BDA. See Figure 40.

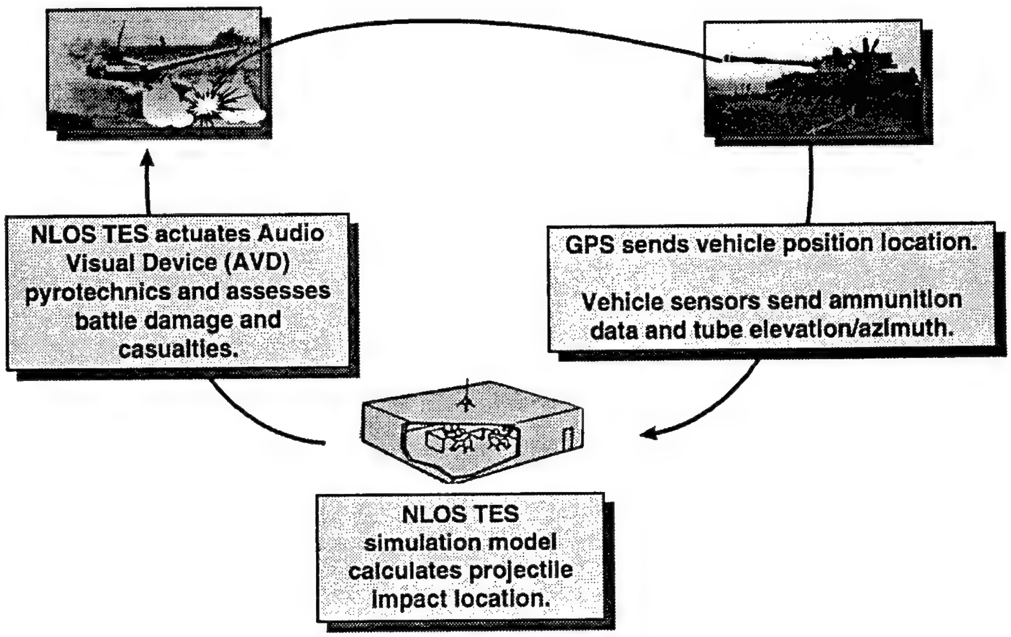


Figure 40. NLOS simulation model

As depicted in Figure 41, integration of an NLOS simulation model with the NLOS TES system to generate BDA will reduce exercise control requirements and improve intrinsic and extrinsic feedback to BLUFOR.

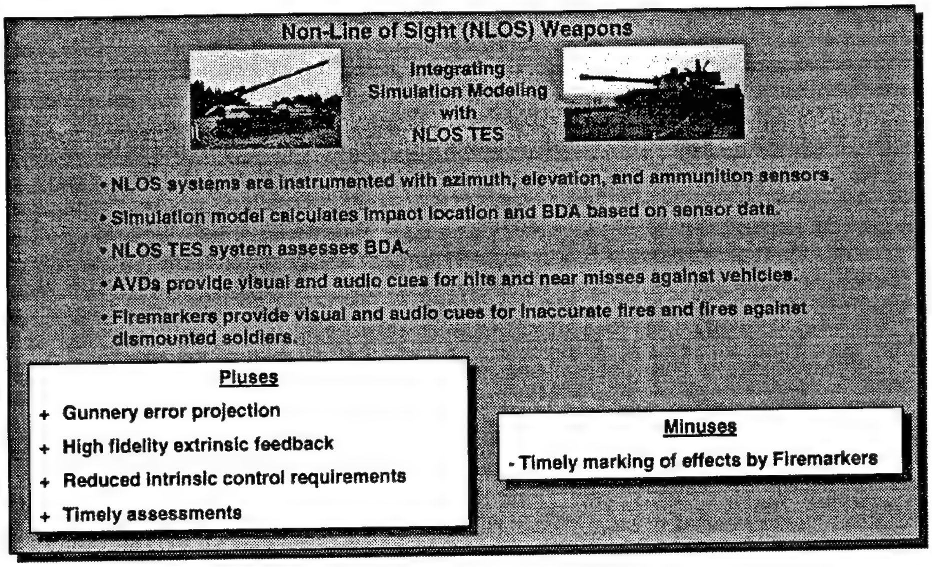


Figure 41. NLOS simulation modeling

With NLOS simulation modeling, OCs can observe and coach FDCs and howitzer/mortar crews rather than meticulously track and report every fire mission to the TAF. Analysts can spend their time analyzing performance rather than manually entering fire missions into the SAWE control station for every BLUFOR fire mission. TAF analysts and OCs can concentrate on critical training issues such as a large discrepancy between the target location in a call for fire and the "should hit" location generated by the NLOS simulation model. Since the simulation model derived the "should hit" location from actual tube locations, azimuths, elevations, and the ammunition type fired, the TAF analyst can perform some meaningful analysis. Based on the reports from the TAF analyst, the OCs can substantively coach the FDCs and the gun line. Since the simulation model generates indirect fires based on actual times for gunnery computations and howitzer/mortar crew procedures, the simulated effects down range better approximate the state of unit training.

This strategy also supports the increasing number of maneuver systems acquiring an indirect fire capability, such as the Abrams Tank Smart Target Activated Fire and Forget (STAFF) round and the Objective Individual Combat Weapon (OICW).

Strategy 2 - Pair Designator to Target Designated

Strategy 1 (Automate NLOS BDA) has the potential to automate and improve the fidelity of most NLOS engagement situations with the exception of remote target designations; i.e., a Copperhead engagement. Today, the FDC OC assesses observer procedures by monitoring the coordination between the observer and the FDC

during the course of the fire mission. To assess BDA for the fire mission, the TAF analyst plots the Copperhead maneuverability footprint on his top-down view of the exercise based on the target location in the call for fire. Then he administratively assesses BDA against the OPFOR upon the fulfillment of two conditions:

(1) The FDC OC confirms that the observer, FDC, and howitzers executed all procedures correctly.

(2) There are OPFOR vehicles within the Copperhead footprint at the time the projectile impacts in the target area.

Remotely designated engagements are not confined to artillery and mortar units. The AH-64A attack helicopter is capable of engaging remotely-designated targets. Control actions for these engagements involve intensive OC and TAF coordination and manual manipulation of the TES system. The number of combat systems capable of engaging remotely-designated targets can overwhelm OCs and TAF analysts and adversely impact on the credibility of the simulation.

Strategy 2 (Pair Designator to Target Designated) proposes that the NLOS TES system possesses the capability to automatically--

- Identify the observer designating the target
- Sense the target designated by the observer and any interruptions in designation
- Ascertain the maneuverability footprint of the ordnance
- Assess BDA within prescribed observer and firer engagement parameters for the ordnance

This strategy can be extended to accommodate systems in which the designator and the firer are the same entity. For example, the AH-64A Apache provides the pilot his own capability to designate targets for engagement by on-board Hellfire missiles.

A combination of Strategy 1 (Automate NLOS BDA) and Strategy 2 (Pair Designator to Target Designated) has great potential to reduce OC and TAF analyst exercise control and training feedback tasks for NLOS laser or radar guided engagements.

Strategy 3 - Pair Shooter to Misses

Is it feasible to integrate a LOS simulation model with a TES system and overcome some of the limitations posed by laser technology? The answer today is "no," but technology advancements in position location may make this course of action feasible in the future.

There is an inherent position location error in live instrumentation. The location errors do not have a significant impact on area fire weapons such as artillery and mortars. The location errors do not impact on the observation and assessment of BLUFOR maneuver, nor on the pairing of shooter to victim for MILES target hits or kills. However, the instrumented position location lacks the precision required by an LOS simulation model to determine hits or misses for weapons designed to engage point targets (Lucha, 1997). See Figure 42.

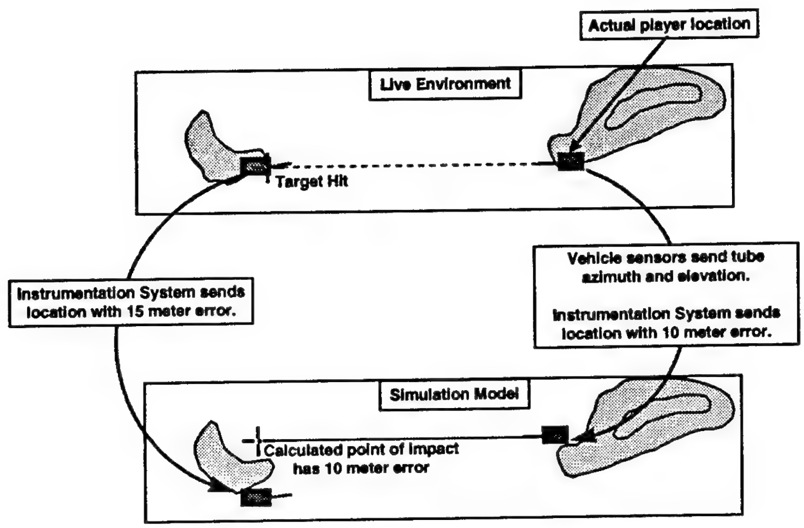


Figure 42. Inherent error in instrumented position locations

In Figure 42, the BLUFOR player is actually located along the southwestern ridge of a hill mass. However, the instrumentation system reports the player's location 10 meters north of his actual position causing the LOS simulation model to position the BLUFOR player on the opposite side of the hill. If an entity's instrumented location has a minor error, the LOS simulation model will contain the same error and promulgate the error during firing events by that entity. In Figure 42, the BLUFOR entity actually hit the target, but the LOS simulation model calculated a miss because of the instrumented position location error of the firer and the target vehicle.

An LOS simulation model may be valuable for the collection of data on LOS misses for AAR purposes. Combining the pairings

of hits/kills collected by the instrumentation system with the misses collected by the LOS simulation model can assist TAF analysts and OCs in assessing the distribution and massing of BLUFOR direct fires. The LOS simulation model can also reveal near-fratricide conditions not displayable by the current instrumentation.

Strategy 4 - Reduce Pyrotechnics Expended for NLOS Battlefield Effects

Today the OC collocated with the howitzer or mortar platoon FDC monitors the call for fire from the observer and monitors FDC procedures in the determination of fire mission data. The FDC OC passes the target location, projectile type, number of projectiles to be fired, and the firing units to the TAF analyst for entry into SAWE. An OC collocated with the howitzers/mortars observes crew actions in preparing for the fire mission and notifies the FDC OC of any errors in weapon lay and ammunition preparations. The FDC OC informs the TAF analyst of any gunnery errors. If there are no gunnery errors, the TAF analyst fires the mission in SAWE. SAWE electronically activates vehicle-mounted AVDs simulating the "flash and bang" of impacting ordnance and assesses casualties and combat damage based on probability of kill tables. For fires that do not fall on AVD-equipped vehicles (inaccurate fires) and for fires that fall on dismounted players, the TAF analyst coordinates the marking of these fires by firemarkers. The TAF analyst coordinates with the nearest OC to assess casualties against dismounted soldiers.

Strategy 4 eliminates the requirements for vehicle AVDs, pyrotechnics, and firemarkers for the simulation of lethal indirect fire munitions by providing the NLOS TES system a capability to project virtual visual and audio effects down range. This strategy is a natural extension of Strategy 1 (Automate NLOS BDA). Recall that in Strategy 1 an NLOS simulation model automatically calculates the location of impacting ordnance based on sensor data from indirect fire platforms. The NLOS TES system then performs BDA based on the proximity of player entities to impacting ordnance, the ammunition type, and volume of fire. Strategy 4 expands the capability of the NLOS simulation model causing the model to depict virtual images of indirect fire on the live battlefield.

This strategy integrates a heads-up virtual visor into the combat vehicle crew (CVC) helmet and portrays virtual images in a Land Warrior type head-mounted display and vehicle gunnery sights to produce 3D visual effects. Earphones provide 3D sound allowing players to hear and sense the approximate vicinity of exploding ordnance. This strategy provides players the

capability to view and hear virtual terminal effects of impacting projectiles generated by the NLOS simulation model. The strategy ties the timing for the production of virtual effects to player actions vice OC, TAF, and firemarker control actions. The observers call for fire, the FDC's gunnery computations, and howitzer/mortar firing procedures determine when and where indirect fires are assessed and marked. See Figure 43.

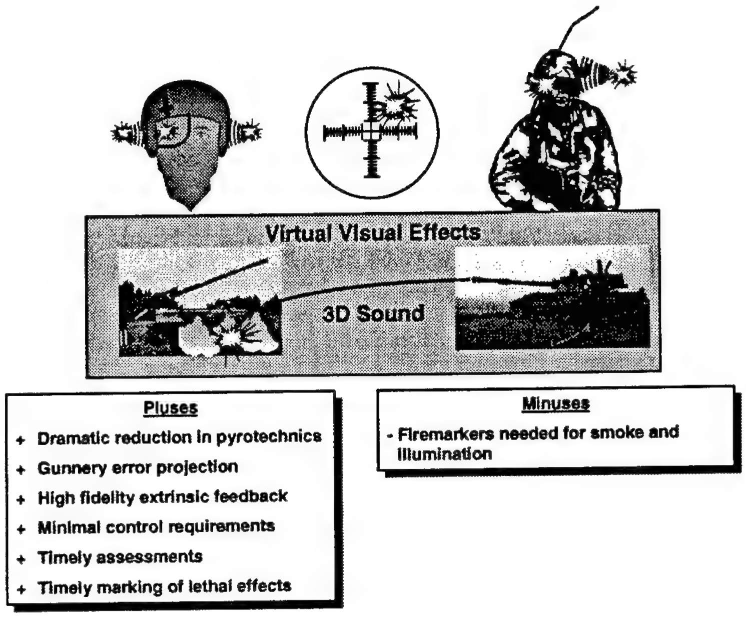


Figure 43. NLOS virtual battlefield effects for NLOS weapons

This strategy has great potential to reduce the number of firemarkers required, dramatically reduce the pyrotechnics expended during training rotations, and produce timely indirect fire effects. This strategy will not totally eliminate firemarkers. Firemarkers must still mark illumination and smoke missions. Virtual illumination rounds may light up a heads-up display but will not illuminate live players. Virtual smoke may obscure the player's vision through a heads-up display but will not obscure the vision of the naked eye.

Strategy 5 - Overcome Limitations of Laser Technology

If position location technology in live training matures to the degree that actual location equals instrumented location, mirroring the live simulation with a parallel running virtual simulation could overcome the limitations of laser-based technology. Virtual mirroring could produce virtual firing signatures and terminal effects for LOS and NLOS engagements using the virtual visor and headphones discussed in the previous strategy.

Virtual mirroring of live training will eliminate laser transmitters and receivers, most pyrotechnic requirements, reduce control requirements, and enhance intrinsic and extrinsic feedback. This strategy has the potential to:

- Permit direct fire through smoke, dust, MILES berms, and leaves (reducing control requirements)

- Provide virtual imagery to depict all firing signatures for direct and indirect fire weapons

- Provide virtual imagery to depict terminal ordnance effects for direct fire hits and misses as well as indirect fire area weapons

- Superimpose virtual battle damage on real vehicles (i.e., track blown off, vehicle on fire) (See Figure 44.)

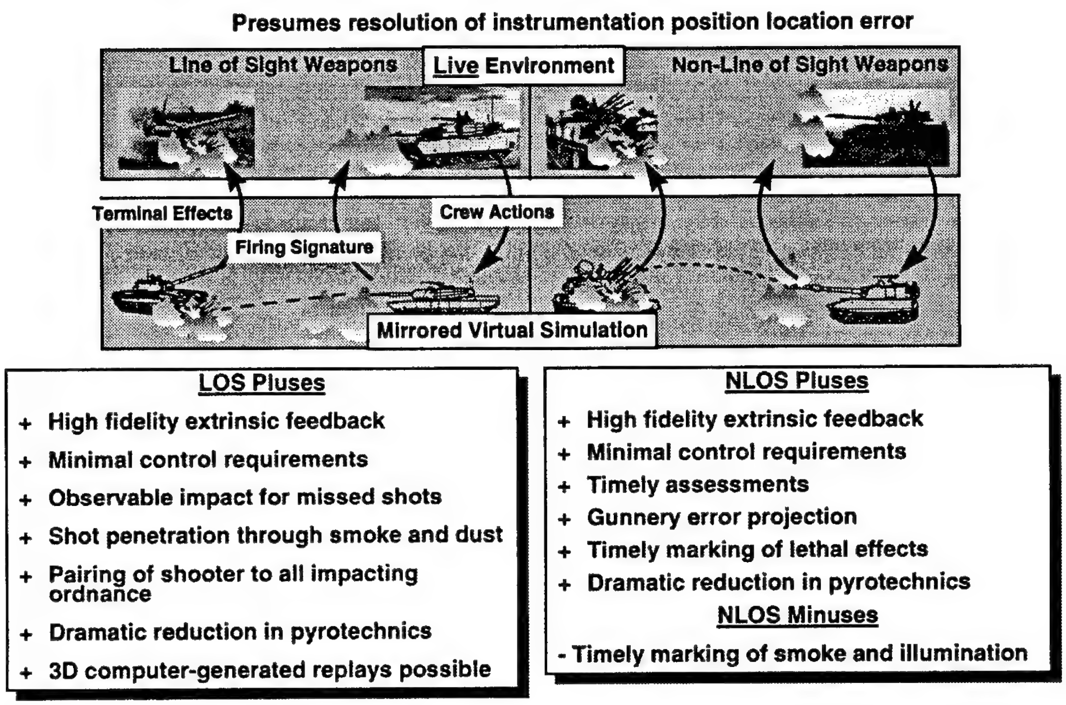


Figure 44. Virtual mirroring

As in the previous strategy, the virtual simulation calculates the locations of ordnance impact and performs BDA using vehicle-installed sensors to determine tube azimuth/elevation and ammunition type. Soldiers and crews see and hear firing signatures and ordnance terminal effects using virtual visors, virtual sights, and earphones.

This strategy adds density sensors to Player Detection Device and Vehicle Detection Device capabilities to detect real overhead cover and real survivability preparations for consideration in casualty and battle damage assessment calculations.

This strategy provides the capability to depict a range of entities and activities not possible in live force-on-force training with today's TES and IS (i.e., missile trajectories and top-down attacks by wide area munitions [WAMs] and the STAFF round). Application of this strategy to the Enhanced Fiber Optic Guided Missile (E-FOGM) allows the E-FOGM crew to virtually "fly" a missile to the target area and attack a live target. As forces drive through a FASCAM minefield, they "see" virtual mines laying on the ground instead of manually emplaced engineer stakes marking the corners of the minefield.

Implementation of the virtual mirroring strategy has the potential to dramatically reduce OC and TAF analyst control requirements and eliminate the need for firemarkers and pyrotechnics except for illumination and smoke. This strategy has wide-ranging applicability and the potential to satisfy most intrinsic and extrinsic feedback requirements of the force modernization systems identified in this study.

For this and previous strategies, we recommend the replacement of numbered TES kill codes with plain language (i.e., "control gun" vice the "00" TES kill code).

Strategy 6 - Provide a Virtual OPFOR

Virtual training currently employs a computer-generated force (CGF) to produce a virtual OPFOR for BLUFOR manned simulators. An exercise controller(s) uses a CGF software application to plan and direct the activities of the virtual OPFOR which behave similarly to manned simulators upon contact with BLUFOR. Strategy 6 has the capabilities of Strategy 5 (Overcome Limitations of Laser Technology) and leverages the CGF technology from virtual simulations inserting a virtual OPFOR on the live battlefield.

This strategy has great potential for home-station live-simulation training. Maneuver area restrictions and the unavailability of live units to serve as OPFOR severely limit the scope of home-station live training. Virtual forces cause no maneuver damage. Exercise controllers can rapidly reset a virtual OPFOR and run the exercise repeatedly from varying starting points to fix training weaknesses. Virtual OPFOR may augment a live OPFOR by serving as second echelon maneuver forces

and supporting units (i.e. OPFOR artillery). This strategy dramatically reduces OC control tasks involving close-in engagements.

The virtual OPFOR strategy does have drawbacks. Although a virtual OPFOR may alleviate the requirement for a live OPFOR, there is an increase in the TAF workload to control and direct the computer-generated force. The live BLUFOR tank crew with thermal sights cannot acquire a virtual OPFOR which presents no thermal signature. The BLUFOR ground surveillance radar (GSR) and the AH-64D Longbow Apache radar cannot acquire a computer-generated OPFOR that has no mass. Identification friend or foe (IFF) equipment receives no stimulation from a virtual OPFOR. Development of a virtual OPFOR that emits an array of signatures to stimulate BLUFOR acquisition capabilities is required to provide a level of fidelity comparable to a live OPFOR.

Strategy 7 - Provide Tactile Feedback

Operations other than war are becoming more frequent, more complex, and politically charged. These new missions bring an increased use of non-lethal weapons such as the aqueous foam barrier and the Acoustic Beam Weapon (ABW). Current TES systems do not support these new weapon systems. Non-lethals pose special challenges for the realism of training. For example, MILES players exist in one of two states. They are either "on" or "off." If a player's MILES sensor receives laser energy, a loud audible alarm goes off. If the player receives a direct hit, he must inactivate his laser transmitter to silence the alarm. This player is now "out-of-action." For intrinsic feedback on the damage sustained, the player must take out a casualty card to identify the extent of his/her wounds. This type of "on" or "off" feedback is sufficient when dealing with deadly weapons like machine guns, but in the non-lethal arena, there are many different levels of effects that are possible. For example, a soldier may use an Acoustic Beam Weapon (ABW) as an area weapon, an invisible barrier, or a point target weapon. The more energy a person gets from an ABW, the greater the effects will be. The higher the weapon setting and the closer the person is to the source, the more energy they will receive. The ABW can make a person feel sick or it can cause serious damage. Additionally, the ABW can operate as both a line of sight and non-line of sight weapon because the ABW has the ability to go through walls and completely flood an area.

There are other challenges posed by non-lethal weapons:

(1) If a reconnaissance soldier starts to enter an area

that has an acoustic beam fence, it would be inappropriate to instantly activate his MILES gear. This could give away his position (loud audible alarm) and require him to remove the transmitter key from his MILES equipped M-16 (inactivating his rifle).

(2) As stated earlier, things like "Tree-leaf defilade" or "Canvas berms" defeat current TES devices.

(3) The ABW has many varying degrees of effect and generally does not "disarm" its targets, unless a target receives extremely high doses of energy.

(4) Once a current TES device is activated, an OC may have to physically "re-key" or "re-activate" that player. Non-lethal weapons may only temporarily disable a player.

As a solution, players need a device that provides tactile feedback in response to the varying degrees of energy received from non-lethal weaponry. For example, when the reconnaissance soldier above first entered an area shielded by an acoustic beam fence, his tactile response device would start slowly tapping him. As the soldier moved closer and closer to the source, the tactile device would tap harder and faster. This would provide a "warning" sensation to the soldier. If that soldier moved away, the tactile device would reduce the tactile response and the soldier could continue the mission without his position being compromised and without his MILES being activated. On the other hand, if that soldier refused to heed the warnings and continued to move into the area, the tactile device ultimately receiving a maximum amount of energy would set-off his TES (e.g., his MILES). At this point, the soldier would become combat ineffective. In this example, the player could feel the tactile device "tapping" him, but the device could produce any number of other sensations such as a slight shock or a vibration. The vibration could be similar to that of a wireless vibrating pager.

In addition, the tactile device must provide automated information on the type of damage sustained (e.g., the injury and the soldier's capability to continue the mission). This capability is analogous to today's MILES casualty cards. The tactile device must also be capable of sending and receiving signals in both line of sight and non-line of sight modes.

Another capability that the tactile device must support is automatic "re-keying." After the tactile device receives its maximum amount of non-lethal energy (different for each non-

lethal weapon), it "sets-off" or activates the soldier's TES system. Then, after the appropriate amount of time and the appropriate reduction of non-lethal energy, the tactile device will automatically "re-activate" or "re-key" the player's TES system. This will account for temporary incapacitation resulting from non-lethal engagements and eliminate the need for an OC to physically re-activate temporarily incapacitated players. For example, if a soldier with a vehicle-mounted ABW directs the maximum amount of energy at an antagonist, that antagonist may buckle-over in discomfort. After the vehicle moved away and after 20 minutes, the antagonist could get up and continue with his mission.

The examples in this strategy deal mostly with the ABW, but the strategy also applies to other non-lethal weapons such as the aqueous foam barrier, dazzling lasers, and the bean bag shotgun. The difference is the maximum amount of energy needed before the tactile device sets off the incapacitating TES (e.g., MILES). Each non-lethal weapon system must have its capabilities and settings modeled in the tactile simulation device.

Strategy 8 - Automate C4I Data Collection and Control

To provide extrinsic C4I feedback to the Bn TF, the instrumentation system must capture all digital traffic transmitted and received by every player node from Bn to platoon level.

Equipping OCs and TAF analysts with BLUFOR digital systems is not sufficient. The information generated by BLUFOR digital systems is overwhelming. OCs and TAF analysts need an automated capability that alerts them to significant BLUFOR digital actions or inactions. This capability will permit OCs and TAF analysts to focus on the cause and effect relationships of critical digital C4I communications.

Determining the information obtained from decision support systems and how BLUFOR used that information in the planning, preparation, and execution of the mission is a major challenge. OCs are ideal for the collection of directly observable human actions; however, the OC is not always in a position to observe C4I workstation operators and their interaction with embedded decision support systems.

The solution may be a C4I system that can access all decision support information available to the BLUFOR. If an OC or TAF analyst subjectively determines that the BLUFOR plan contains flaws, the TAF analyst should be able to use the AAR system to automatically retrieve decision support information

available on the aspect of the plan found deficient. Then during the AAR, the OC may ask members of the AAR audience what decision support information they consulted, who they informed of their findings, and what information proved useful in generating courses of action and arriving at a decision.

The AAR becomes the means by which the OCs learn the decision support information players consulted and how they used it. This approach (subjective assessment followed by an examination of pertinent decision support products available to BLUFOR) can lead to automation of decision support products based on typical OC assessments. For example, a typical OC assessment might conclude that the unit did not weight the most vulnerable sector during the defense. Software linking this subjective assessment to supporting decision support information in the tactical C4I system can confirm or deny the OC's assessment. If the decision support information confirms his assessment, he can use the decision support products to generate discussion and learning during the AAR.

Strategy 9 - Automate Tracking of Player Activities and Expended Resources

The Joint Total Asset Visibility (JTAV) Office developed the Defense Total Asset Visibility (TAV) Implementation Plan. Total Asset Visibility is defined as the capability to provide timely and accurate information on the location, movement, status, and identity of units, personnel, equipment, and supplies. TAV includes the capability to act on that information to improve the overall performance of the Department of Defense logistics practices. In addition, TAV includes the ability to provide timely and accurate status on all types of requisitions (Joint Total Asset Visibility Office, 1995).

The Defense Total Asset Visibility Implementation Plan focuses on four main topics: requisition tracking, visibility of assets in-storage or in-process, visibility of assets in-transit, and logistics management within a theater of operation. Total Asset Visibility (TAV) is not one single system but is comprised of a family of current and developing computer systems. TAV designers are in the process of integrating and standardizing these systems. Current asset visibility systems include the Logistics Information Processing System (LIPS), the Defense Automatic Addressing System (DAAS), and the Global Transportation Network (GTN). TAV operations between garrison and deployment will be seamless providing a capability to accurately and instantly capture data on the various assets. This is called automatic identification technology (AIT). Developers are testing several different technologies designed to support this

process. AIT systems currently employ the following techniques for capturing and processing asset data: bar codes, magnetic strips, optical memory cards, and radio frequency (RF) tags. These tracking devices and counterpart computer management systems provide planners, commanders, and users with the information and assets they need, when they need them. TAV enables practices such as "just-in-time" stocking and delivery. TAV also helps to prevent backlogs in the system because users will know where the assets are, where they need to go, and the specific status of each request. TAV systems and their tracking capabilities generally go down as far as brigade (Joint Total Asset Visibility Office, 1995).

We suggest a strategy that follows the TAV concept but tracks the use and consumption of simulated resources (i.e., ammunition and mines) from the brigade support area to their final destinations. The objective of the strategy is to track the movement of simulated supplies (i.e., number of STAFF rounds, WAM mines, cases of small arms ammunition) to their ultimate consumption by the squad/crew. NOTE: For actual resources (i.e., barrier materials), JRTC suggests reuse of Automated Identification Technology in conjunction with hand held interrogators to track supplies from the brigade support area to their final destination.

Our strategy employs electronic "widgets" called Activity and Resource Keys to track simulated resources and player activity. Players will electronically enter Activity and Resource Key information into their vehicle detection devices (VDDs) and player detection devices (PDDs) and ultimately into the instrumentation data stream. This approach enables OCs and TAF analysts to track player activities and expended resources. We believe this strategy has the potential to substantially reduce trainer control actions and data collection tasks. In the paragraphs that follow, we provide examples of how BLUFOR players might employ Activity and Resource keys and automate exercise control, battle damage assessments, and data collection requirements. This strategy also has the potential to drive BLUFOR CSS activities for simulated supplies.

Minefield Example

Our first example of the Activity and Resource Key strategy is mine emplacement. In current procedures, an OC observes the emplacement of the minefield and provides the location, type mines, density, and orientation of the minefield to the TAF analyst. The TAF analyst then enters the minefield information into SAWE which kills any vehicle entering the minefield according to an established probability of kill (PK). These control and TES procedures are inadequate to simulate the capabilities of the Raptor, formerly known as the Intelligent Minefield. In addition to a self-detonation capability, an operator at a remote control station may command detonate the entire Raptor minefield or selected mines. Simulating the command detonation capabilities of the Raptor is not possible with the current SAWE simulation.

Using electronic Activity and Resource Keys, exercise players can enter the locations of individual mines into the IS. As engineer soldiers prepare to emplace a Raptor minefield, they will enter the mine emplacement Activity Key (Figure 45) into their PDDs which transmit the soldiers' location and activity through the IS to the TAF.

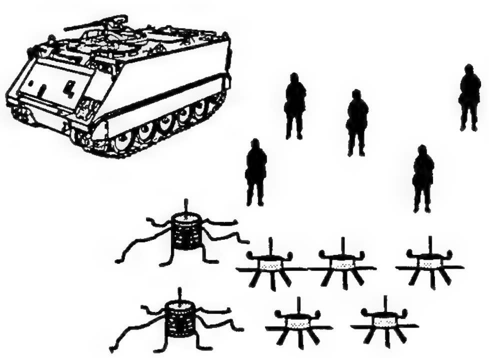


Figure 45. Activity Key: emplacing minefield

As each soldier emplaces a mine, he designates a setting for command detonation or self detonation using the mine Resource Key (Figure 46). Next, he inserts the key into his PDD. This transmits the mine location and detonation parameters to the instrumentation system. The instrumentation system enters this information into the TES and plots the individual mine locations and their settings on the analyst's top-down view.

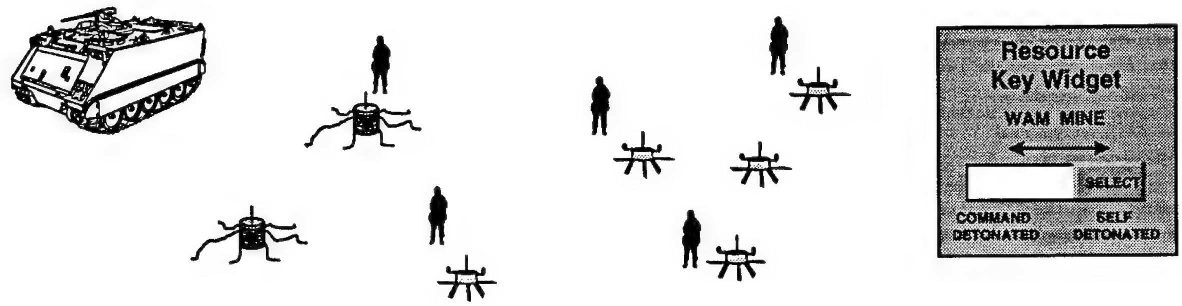


Figure 46. Resource Key: WAM mine

For mines set for command detonation, a player at the Raptor control station will notify the TAF analyst on a control net which mines or mine belt the player intends to command detonate. On the player's command, the TAF analyst will detonate the designated mines using the IS. (Interfacing the Raptor control console with the instrumentation system could eliminate this control task.) If mines are set for self-activation, the TES will automatically plot a 100 meter radius around each mine. If a vehicle comes within 100 meters of a mine, the TES will automatically assess casualties and battle damage and produce battle field effects (flash-bang).

CSS Example

CSS is another area in which activity and resource keys have a high potential to reduce OC and TAF analyst workload. When BLUFOR vehicles suffer simulated combat damage, control requirements are labor intensive. An OC must monitor each step of the CSS process. BLUFOR must request the parts to repair the vehicle, assemble the necessary maintenance personnel, and wait a prescribed period of time to effect the repairs. The OC then returns the vehicle to a fully-operational status. If a vehicle requires evacuation to the combat or field trains for repair, a BLUFOR recovery vehicle must lead the simulated battle damaged vehicle (which moves under its own power) to the repair site. After a prescribed period of time, the OC permits the repaired vehicle to return to its parent organization.

Using the Activity and Resource Keys, a maintenance crew will perform repairs by entering a repair Activity Key into the VDD (Figure 47). Entering the key will start the clock for the repair action. The individual can perform no other function, such as repairing another vehicle, while the repair activity is in progress. If the maintenance crew interrupts the repair activity to engage in a different activity, the activity timer "bookmarks" the time expended and the time remaining to complete the original activity. Upon completion of the repair activity,

the VDD senses that repairs are complete and restores the vehicle to an operational state.

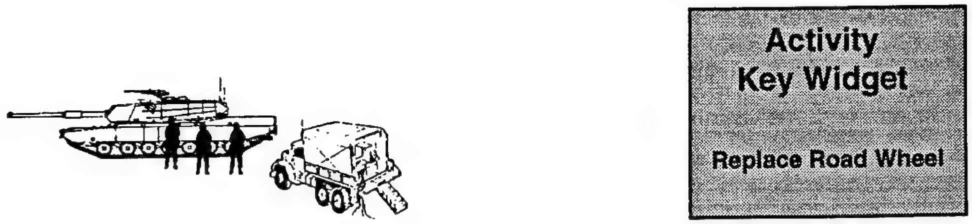


Figure 47. Activity Key: replace road wheel

If the maintenance activity requires repair parts (resources), repair personnel must enter necessary Resource Keys into the VDD to complete the repair. (Figure 48) If the required Resource Key(s) is not available, the maintenance personnel will be unable to complete the repair activity. As units expend Resource Keys, they must execute resupply activities to obtain replacement keys.

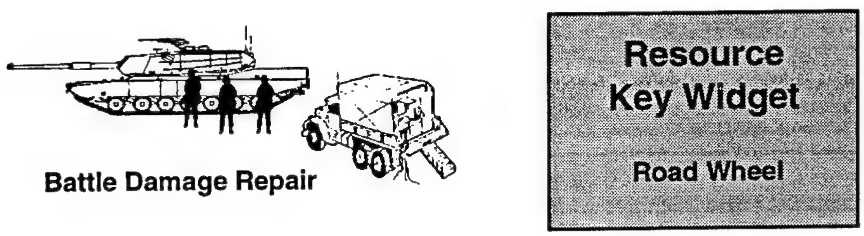


Figure 48. Resource Key: road wheel

Ammunition Expended Example

The firing of specific munitions is another area where the resource key may be effective in entering information electronically into the TES and IS. For example, a tank crew may fire a Smart Target Activated Fire and Forget (STAFF) round for a top-down attack against an enemy armor vehicle in defilade. If the TES system is not aware that the crew is firing a STAFF round, the system will treat the firing event as a LOS engagement. The result--the gunner will miss the enemy vehicle even if his gunnery procedures are perfect. If the crew enters a STAFF round Resource Key into the VDD prior to firing, the TES system can apply NLOS criteria to assess the crew's engagement. Entering the STAFF round Resource Key into the VDD also decrements the round count from onboard stores and renders the key unusable to load another round. The crew must use another STAFF key to load a second round. This procedure causes the crew to execute resupply actions to secure additional STAFF round Resource Keys.

Activity and Resource Keys provide a capability to electronically track player simulated activities and resources. The strategy also reduces the requirements for OC control actions to provide exercise players the needed intrinsic feedback; i.e., repair actions are complete; vehicle is operational.

Strategy 10 - Automate TES System Monitoring

Currently, OCs manually check each player TES with a control gun to ensure players can be killed. If the OC finds a faulty TES, he administratively kills the vehicle. If the OC discovers the faulty TES during the planning and preparation phases of the exercise, he assists the unit in diagnosing and correcting the problem. If the OC discovers the malfunctioning TES during the execution of the battle, he administratively kills the vehicle and continues to the monitor the activity of the remaining live players. The administratively-killed players do not participate in the remainder of the exercise. If the TES problem is beyond the capability of the player unit to correct, the OC contacts a TES contact team to repair or replace the malfunctioning TES.

Automating TES system testing will provide more consistent testing, reduce OC workload, and enhance the credibility of the simulation. Automated TES monitoring has the potential to provide administratively-killed players with the opportunity to continue to participate in the exercise if they are able to correct the TES fault.

A TES monitoring system which "pings" each player entity could routinely check all TES systems periodically. The "pings" will not activate the VDD's amber light nor the PDD's audible alarm. If the monitoring system discovers a faulty VDD or PDD, the system will administratively kill the player, diagnose the fault, inform the OC and TAF analyst of the player ID and TES fault, and notify the TES contact team of the player ID and diagnosis. Upon receiving an administrative kill, the PDD or VDD will notify the player of the fault. If the player corrects the fault, the TES monitoring system will resurrect the PDD or VDD at the next "ping" so players may continue to participate in the exercise.

Strategy 11 - Automate AAR Preparations

A strategy that leverages OC and TAF analyst subjective assessments has great potential to automate AAR preparations. An example of a subjective assessment might be: "The unit is weak in performing actions on the objective."

Under this strategy researchers will interview OCs and TAF analysts to determine:

- Typical subjective assessments made for each exercise mission (i.e., hasty attack, defend from battle position)

- Typical AAR aids prepared by the CTCs to support OC and TAF analyst subjective judgments

A good starting point for typical subjective assessments is the Center for Army Lessons Learned (CALL) Maneuver CTC trends which contain positive and negative performance trends by BOS.

Following the determination of typical OC and TAF analyst subjective assessments and the identification of typical AAR aids that support each assessment, an AAR knowledge base will be developed. The knowledge base will contain algorithms and AAR formats that exploit the instrumentation data stream to automate the production and retrieval of AAR aids. A set of AAR aids will be designed for each subjective assessment based on interviews with OCs and TAF analysts. These AAR aid sets will provide candidate aids for the AAR and may also serve to confirm or deny OC and analyst subjective judgments.

Figure 49 illustrates the concept of this strategy. The TAF analyst selects the appropriate BOS for the OC's subjective assessment. In this example the analyst selects the maneuver BOS, and a list of assessments appears. The analyst highlights the assessment that closely matches the OC's subjective assessment then clicks on the AAR aids button. The system presents a set of AAR aids for the analyst's consideration. As the library of aids grows in number and sophistication, the system will categorize assessments by tactical missions and other categories--planning, preparation, and execution. TAF analysts will ultimately need a search capability to locate aids across all subjective assessments.

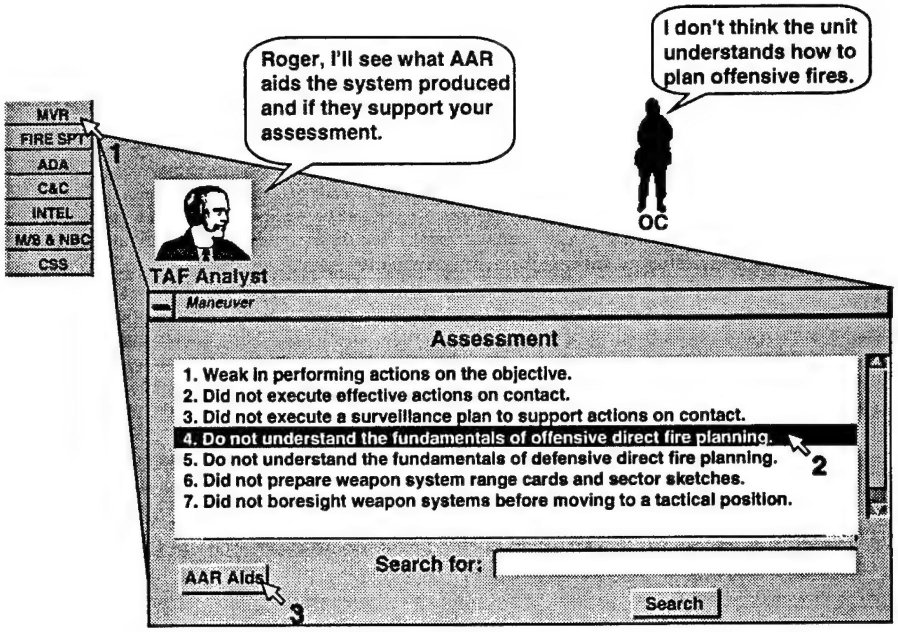
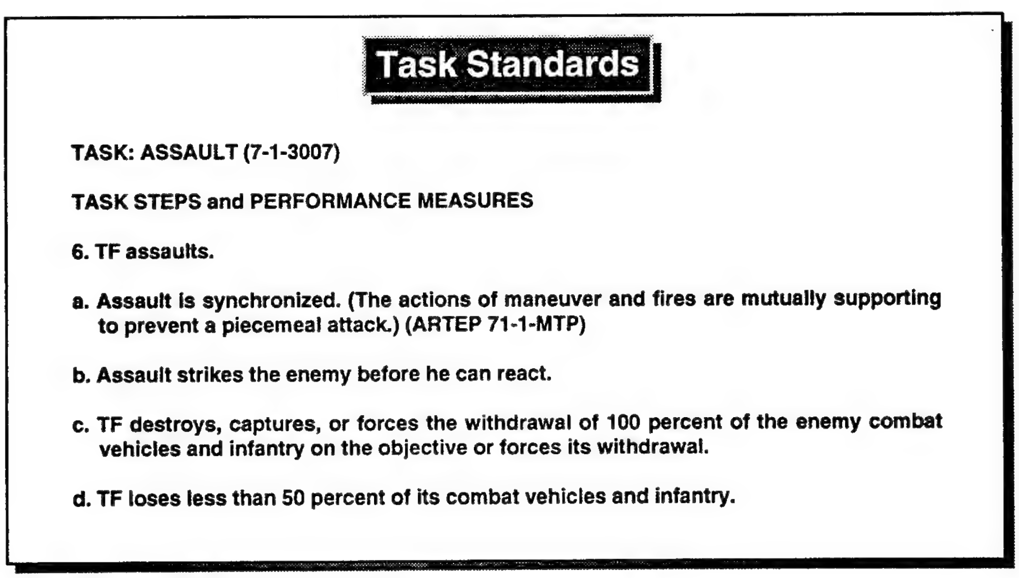


Figure 49. Selection of subjective evaluation

The system provided the information in the following nine figures, based on the operator's selection of subjective assessment 4: "Do not understand the fundamentals of offensive direct fire planning."

Figure 50 provides the performance measures for a Bn TF assault.



Task Standards

TASK: ASSAULT (7-1-3007)

TASK STEPS and PERFORMANCE MEASURES

6. TF assaults.

a. Assault is synchronized. (The actions of maneuver and fires are mutually supporting to prevent a piecemeal attack.) (ARTEP 71-1-MTP)

b. Assault strikes the enemy before he can react.

c. TF destroys, captures, or forces the withdrawal of 100 percent of the enemy combat vehicles and infantry on the objective or forces its withdrawal.

d. TF loses less than 50 percent of its combat vehicles and infantry.

Figure 50. Aid 1 - task standards

Figure 51 provides the Bn TF mission and an overview of the TF plan.

Mission: Task Force conducts a deliberate attack against a Motorized Rifle Company at 90 percent strength (three T72s and nine BMPs) postured in a hasty defense.

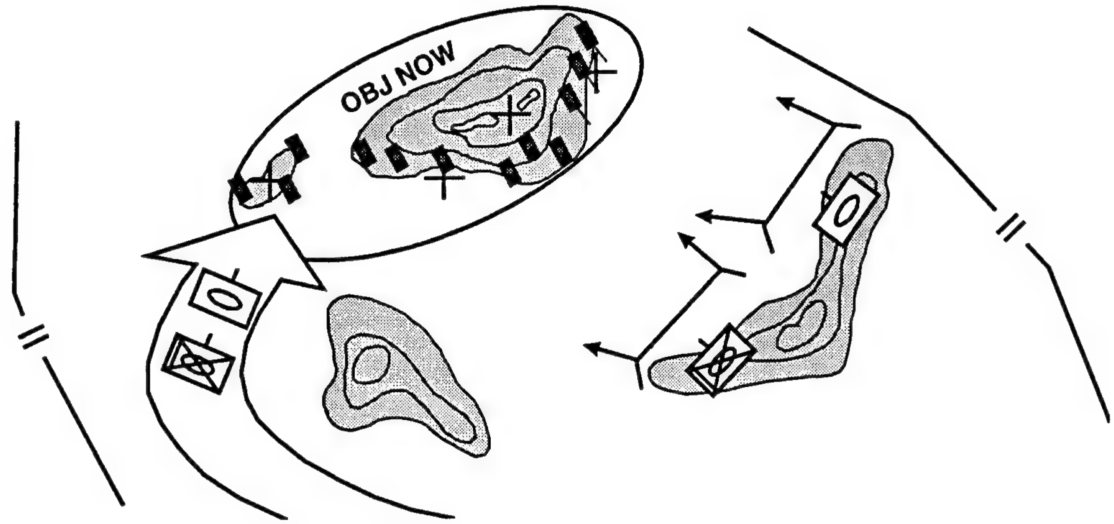


Figure 51. Aid 2 - Bn TF plan

Figure 52 shows the battle outcome indicating BLUFOR and OPFOR operational systems at the beginning and end of the battle.

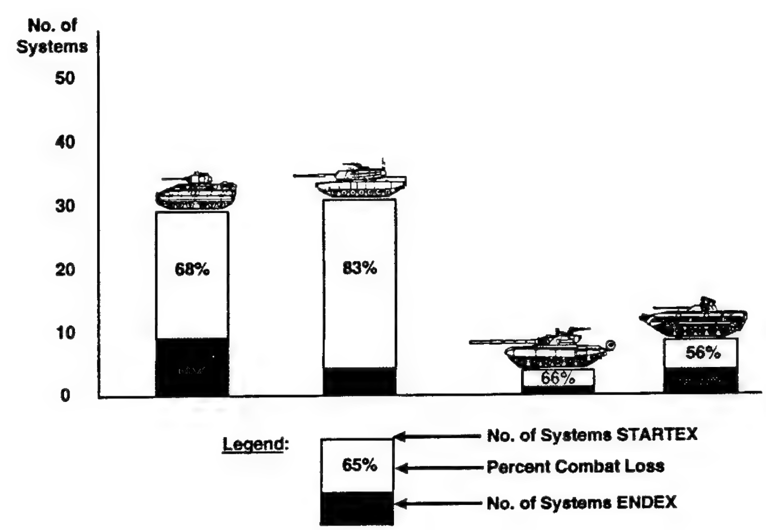


Figure 52. Aid 3 - battle outcome

Another aid (Figure 53) shows BLUFOR direct fire distribution during the assault on the objective. Preparation of this aid is dependent upon instrumented data that provides the impact location of direct fire misses as well as hits. The aid

also provides candidate questions the OC may ask to generate discussion during the AAR on BLUFOR performance.

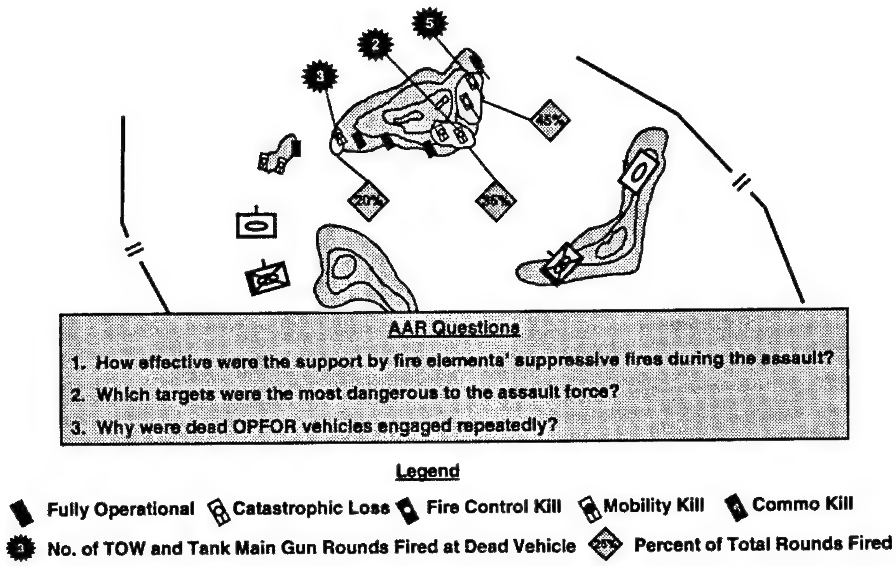


Figure 53. Aid 4 - direct fire distribution

Figure 54 replays clips of the BLUFOR assault from a top-down view. The system also replays synchronized audio from the tactical voice net, isolating fire commands issued by Company Team Cdrs during the assault.

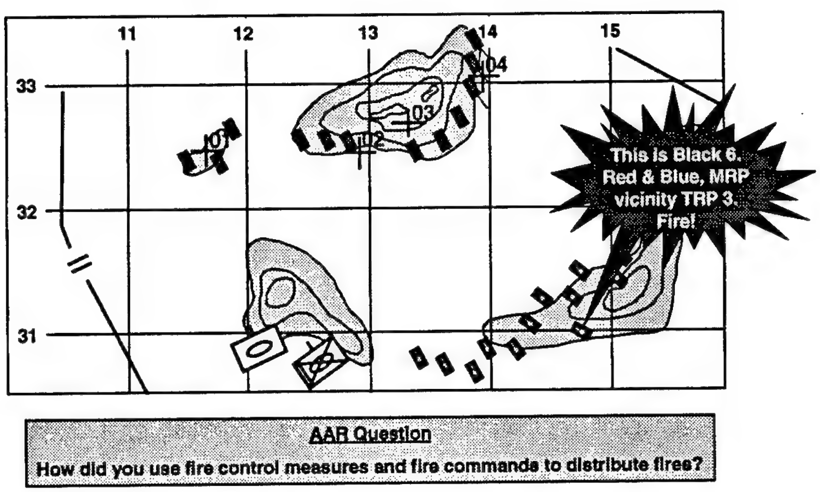


Figure 54. Aid 5 - voice fire commands

Figure 55 shows the indirect fire distribution of casualty-producing munitions and smoke during the assault.

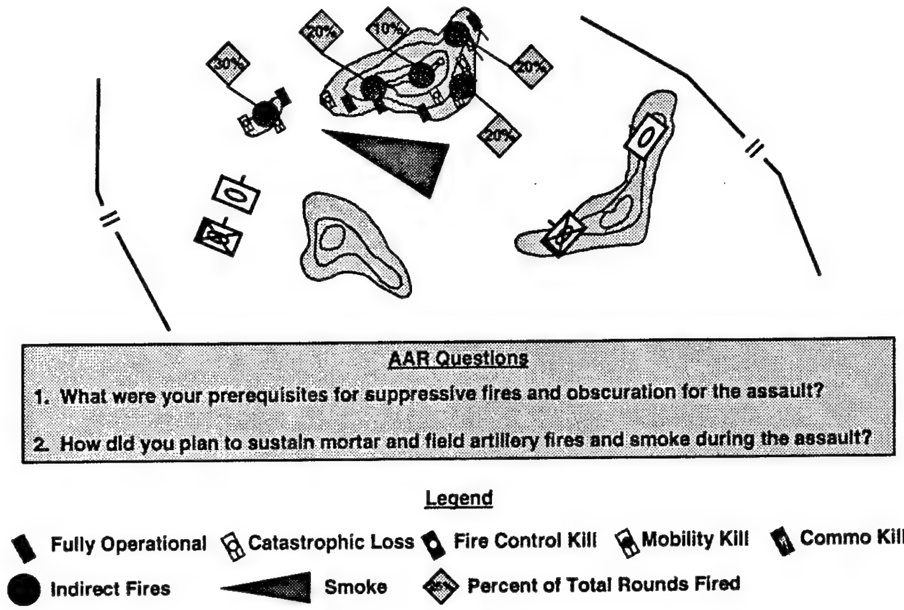


Figure 55. Aid 6 - indirect fire distribution

Figure 56 is a video depicting the smoke during the assault. The video reveals that BLUFOR did not obscure the vision of many OPFOR combat vehicles during the assault.

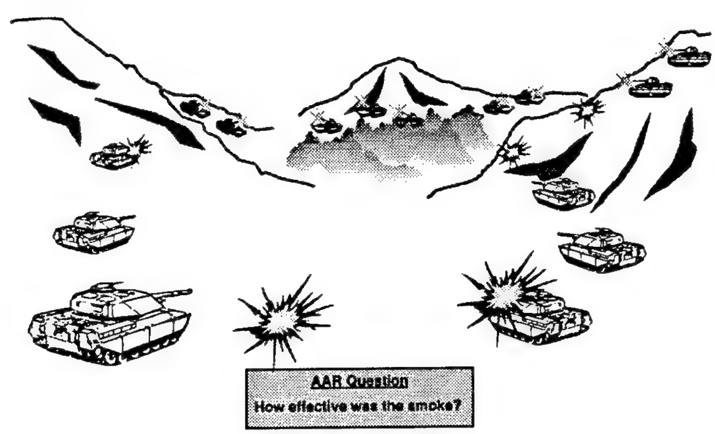
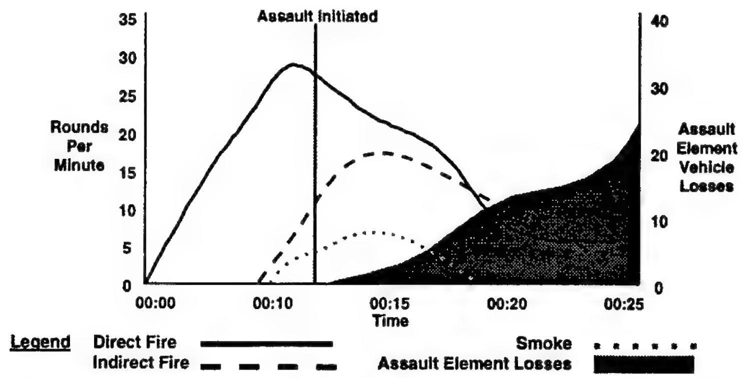


Figure 56. Aid 7 - video of BLUFOR smoke

There may be occasions when an OC or TAF analyst needs a 3-dimensional (3D) view of a BLUFOR activity not covered by a mobile video crew. If there is a mirrored virtual simulation produced by the live simulation as proposed by Strategy 5 (Overcome Limitations of Laser Technology), the TAF analyst may produce Stealth 3D views of player activity.

Figure 57 shows the effectiveness of the support by fire elements to suppress OPFOR fires and to protect the assaulting elements of the TF. In this example, the suppressive fires of

the support by fire element diminished during the assault causing high losses to the assaulting elements.



AAR Questions

1. How did you estimate the time required to complete the assault?
2. How did you know when to begin suppressive fires?
3. How did you plan to reload ammunition to sustain fires during the assault?

Figure 57. Aid 8 - effectiveness of support by fire elements

Figure 58 is available to support heavy coaching by the OC in the event the AAR audience does not generate substantive discussions on how to improve their performance.

How to Improve

"Massing fires is not 14 vehicles all destroying one target. True massing of fires is 14 vehicles destroying 14 different targets."

Principles of direct fire:

1. Avoid target overkill.
2. Use each system in its best role.
3. Concentrate on long-range targets.
4. Take the best shots and expose only those combat vehicles actually needed to fire.
5. Destroy the most dangerous targets first.

Fire Control:

1. Target Reference Points (TRPs) – man-made, existing terrain feature, enemy position, or formation
2. Engagement Areas (EAs) – terrain oriented
3. Fire Patterns – enemy oriented
4. Fire Techniques – control of volume, rate of fire, and number of vehicles firing
5. Fire Commands – verbal orders to synchronize fires
6. Engagement Priorities – specific friendly weapons assigned priorities of engagement against specific enemy systems by type

Figure 58. Aid 9 - OC coaching

TAF analysts may also archive examples of desired performance from previous exercises that OCs may use to show "a way" on how to improve performance. If computer-generated force

(CGF) software is available to the TAF analyst, he may develop and archive a CGF scenario to illustrate "a way" to improve for a common BLUFOR problem area. The AAR system should automatically provide the OC and TAF analyst appropriate selections from a library of "a way" AAR aids.

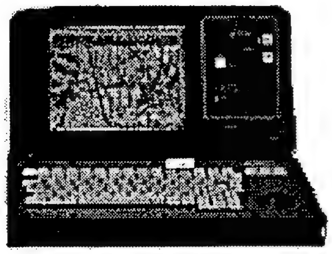
In this strategy, the AAR workstation automatically produces the AAR aids using artificial intelligence (AI), standard AAR formats, and the data collected by the instrumentation system. The subject matter expertise for the content and design of the aids will come from interviews with CTC OCs and TAF analysts. As the aids are prepared, Subject Matter Expert (SME) reviews will approve the AAR aid sets for each subjective assessment. It is unlikely that the knowledge base will contain all AAR aids needed for training exercises. Consequently, the AAR workstation must provide the TAF analyst the flexibility to select and edit system-prepared aids and to prepare AAR aids manually.

Using AI the AAR workstation is capable of generating a large number of aids but not all of these aids will be significant. The OC must manually select which aids he presents during the AAR based on those aspects of BLUFOR performance that had the greatest impact on battle outcome. The intelligent AAR system provides aids that reflect player activity during key events. SMEs can establish parameters that equate to "key" events. For example, SMEs might designate that the loss of 50% of a unit's combat power is a "key" event. When a unit meets this parameter, the AAR AI looks back in exercise history and identifies the various decision points that led to that event. The AI automatically puts the AAR aids that correspond with the various decision points at the top of the priority list. In addition, the AI identifies information sources the player unit was capable of accessing at each decision point. The AI links these "Available Information Aids" to the decision points and presents candidate aids to the OC for selection or editing. The automated creation and prioritization of these aids reduces AAR preparation time, promotes standardization, and focuses the AAR on key issues.

Strategy 12 - OC Control, Observation, and FBCB2 Workstation

OCs need a mobile workstation to support their control and observation requirements. The workstation should support OC control and coordination needs and provide the OC the capability to monitor his BLUFOR counterpart's digital activities; i.e., a Control, Observation, and FBCB2 (COF) workstation. In this strategy, the COF displays the locations of other OCs, firemarkers, video crews, and ground truth BLUFOR and OPFOR entities. The COF provides the OC situational awareness so he

may modify his control and observation plan "on the fly" to preclude unobserved or uncontrolled events. See Figure 59.



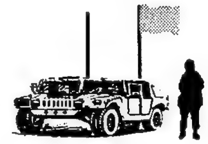


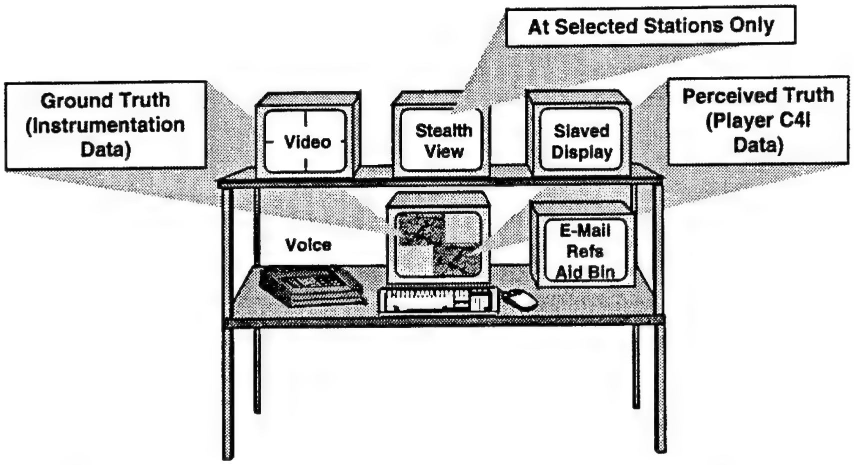
Figure 59. OC COF workstation

The COF provides the OC a wireless e-mail and voice-mail capability to coordinate and pass reports. The OC has a hands-free capability to electronically input observations, timelines, and information for required reports by voice, as well as through the keyboard. The COF supports the OC with a remote voice capability so he may observe player activities away from his vehicle and still monitor his voice control net. The OC accesses all references, reports, checklists, BDA tables, and briefings through the COF. The OC consults the COF for training materials he may use to coach his BLUFOR counterpart on how to improve performance.

The COF will not eliminate OC control and feedback tasks. However, the system will reduce the level of effort required to perform OC control, observation, coordination, and mentoring tasks. The COF will give the OC the freedom to leave his vehicle and observe BLUFOR TOC activities during the battle and still respond to radio calls on the control net. The OC will utter his observations (i.e., "As of 05:15 hours, C Team has not prepared survivability positions."), and the COF will translate his dictation into digital text. COF capabilities will maximize the training benefits OCs provide to the rotating unit by providing situational awareness, immediate access to required references, and features that minimize time spent on control, coordination, and reporting requirements.

Strategy 13 - TAF Analyst Workstation

In this strategy the Instrumentation System (IS) archives two-dimensional (2D) and three-dimensional (3D) computer-generated imagery, video, audio (voice), C4I digital data, and all e-mail and digital reports exchanged among OCs and TAF analysts. See Figure 60.



Captures and time-stamps all media for synchronized playback and employs:

- Strategy 8 - Automate C4I Control and Data Collection
- Strategy 11 - Automate AAR Preparations
- Strategy 12 - OC Control, Observation, and FBCB2 Workstation

Figure 60. TAF workstation

All displays permit the analyst to view the exercise in real time or to slew-back in time and view all media in synchronization. When the analyst slews-back the clock into exercise history, he sees the video, audio, C4I information, and computer-generated imagery corresponding to that moment in time. Capture and time-stamping all media permits dissection of critical tactical events by the TAF analyst and other analysts who research archived exercises stored at the National Simulation Center.

If there is a mirrored virtual simulation produced by the live simulation, as proposed by Strategy 5 (Overcome Limitations of Laser Technology), the TAF analyst can view 3D computer-generated views of player activity from any point on the battlefield. In virtual simulations this capability is referred to as the Stealth Vehicle view. Computer image generators for 3D views are expensive and may have limited use at Bn TF and above. This strategy recommends limited distribution of the Stealth view in the TAF; i.e. two or three per TAF team.

The slaved display permits the analyst to view the display of any other analyst in the TAF. For example, the senior Bn TF analyst may view the Bn TF situation on his primary top-down view and view a close-up of a company team on his slaved display.

The TAF analyst may use the workstation's voice communications capability to eavesdrop on BLUFOR nets and to transmit and receive voice traffic on OC control nets. He may

use the communications console to talk or conference with other TAF analysts or make telephone calls.

The display on the lower right of the workstation in Figure 60 provides the analyst the capability to send and receive e-mail and reports from OCs or other analysts. The TAF analyst accesses his references and stored AAR aids from this console. As OCs submit their exercise summaries, the TAF analyst organizes and stores their input for the unit THP.

The center console permits the analyst to display "ground truth" data provided by the instrumentation system and "perceived truth" data obtained from BLUFOR C4I digital communications. In Figure 60 we show "ground truth" and "perceived truth" on a single monitor to emphasize that the IS must integrate C4I data with currently instrumented data. If the IS does not capture C4I data:

- The analyst must manually transfer the information (i.e., an overlay) from the tactical C4I system (i.e., FBCB2) to the instrumentation system
- The analyst must manually synchronize digital data from tactical C4I systems with instrumented data for analysis
- ABCS data will not be available for research and post-rotation analysis

It is not our intention to influence the technical design of the TAF analyst workstation by our illustration in Figure 60. The objective of the figure and our discussion is to point out workstation functional requirements revealed by our analysis.

Figure 61 shows ABCS systems required by the analysts of a Bn TF TAF team to monitor the digital activities of the BLUFOR. Each analyst must be equipped with the digital system used by his BLUFOR counterpart to monitor that player's situational awareness, digital communications, and access to external information. CSSCS is not a Bn TF system; however, the CSS analyst will need the system to monitor and provide extrinsic feedback on TF CSS activities.

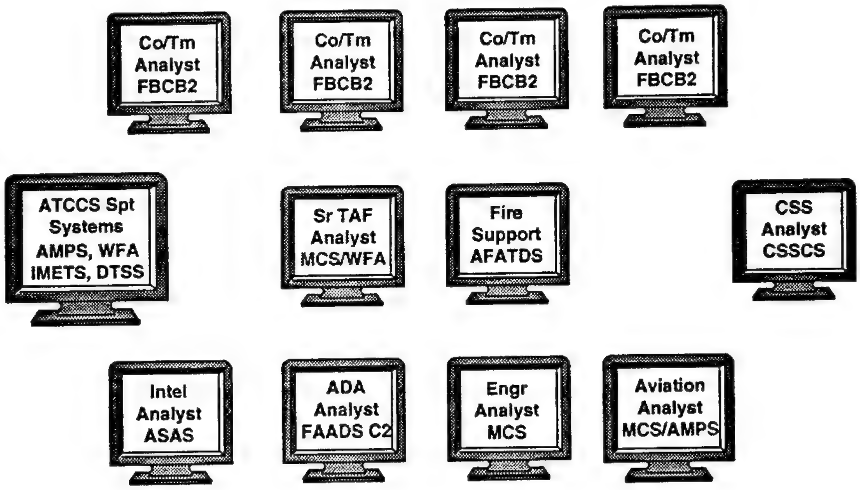
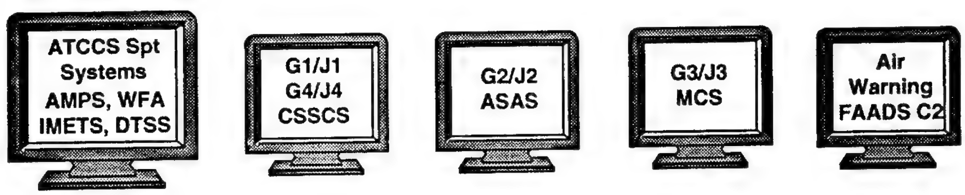


Figure 61. Bn TAF C4I configuration

To provide the rotating Bn TF the intrinsic feedback it needs from a higher headquarters, the CTC exercise management and control cell (EMCC) will require access to ABCS capabilities. See Figure 62. Personnel and ABCS equipment from the rotating unit's division headquarters or brigade may augment the EMCC to support passing of digital orders, requests, and reports directly to the BLUFOR TF or through the parent brigade.



NOTES:

1. CTCs may rely on operators and equipment from the rotating unit's parent headquarters.
2. DIVARTY and DIV FSE represented by TAF Fire Support Section which also supports the Bn TAF Team.

Figure 62. EMCC C4I configuration

Home-station Training

Home-station force-on-force training differs from training at the maneuver CTCs in the following ways:

(1) There is no instrumentation system to provide a "ground truth" view of BLUFOR and OPFOR depicting entity location, status, and direct and indirect fire engagements. There is no capability to record, time-tag, and play-back voice communications.

(2) There are no mobile video crews to record significant player actions and examples of desired performance.

(3) The Bn TF uses the MILES TES but has no SAWE capability for indirect fires.

(4) Sister maneuver and artillery units normally provide the OCs, firemarkers, and a firemarker control capability.

(5) There is no dedicated TAF analyst team to build AAR products. Appointed home-station OCs prepare their observations, identify key performance issues, and prepare AAR products. Home-station AAR aids generally include:

- Maps and overlays
- Terrain models constructed on the ground
- Butcher charts containing sketches and text
- Powerpoint slides

(6) Home-station force-on-force training has no dedicated OPFOR. A sister unit normally provides the OPFOR.

(7) The home-station maneuver area is often more confining than the CTC exercise area. Home-station restrictions may not permit some training activities such as the generation of smoke.

The Home-station Training Instrumentation (HTI) will provide a deployable instrumentation system with a TAF capability. The HTI TAF will be capable of exporting AAR products to mobile facilities, fixed facilities, remotely networked facilities, and the tactical C4I workstations in tactical operation centers (TOCs). HTI will also have the capability to support preparation and assembly of unit THPs. The military installation will

provide the operators for the HTI TAF workstations. These operators will probably be trainers from non-player units and the player unit's higher headquarters.

Appointed HTI TAF workstation operators will change from one unit rotational training cycle to the next as exercise support personnel transition from non-player duties to player duties. Design of the workstation must take into consideration that the operator may operate the system intensively for two weeks then go for three months before operating the system again.

With the development of the HTI system, all of the strategies developed for the CTCs may be applied to home-station training. Strategy 8 (Automate C4I Data Collection and Control) provides the HTI TAF operator the capability to transmit digital traffic in a control role and to eavesdrop on the digital communications of any player. The system stores all digital messaging, alerting the operator to significant unit digital actions or inactions, disparities in situational awareness, and failures to adhere to digital and voice TTP. Since operators will change between training cycles, Strategy 11 (Automate AAR Preparations) becomes a critical requirement for HTI TAF workstation operators. Because of their limited experience in preparing multimedia AAR aids, operators will need a system that provides automated, standardized AAR products by BOS and echelon. The capabilities provided by Strategy 13 (Upgrade TAF analyst Workstation) are also critical to support exercise management and control functions, OC and TAF coordination, monitoring of player voice and digital communications, and observation of ground truth and perceived truth situations.

Strategy 12 (Provide a Control, Observation, and FBCB2 Workstation) equips the home-station OC with a mobile workstation to support his control and observation duties. He uses the workstation to access needed references, develop his control and observation plan, submit hands-free digital reports and exercise summaries, and monitor the digital activity of his BLUFOR counterpart.

Eight strategies propose concepts to reduce control and feedback workload due to MILES intrinsic and extrinsic feedback limitations for non-lethal engagements and maneuver, aviation, engineer, artillery, and mortar NLOS/top-down engagements. Implementation of the eight strategies will dramatically reduce manual control and data collection tasks in both home-station and CTC live training exercises. We quantify the workload reduction in the "Conclusions" section of the report where we map strategies to OC and TAF analyst tasks eliminated. In addition to task reduction, the strategies provide a spin-off benefit of improved simulation fidelity.

Strategy 6 (Provide a Virtual OPFOR) may be highly beneficial to home-station training. Maneuver area restrictions and the unavailability of live units to serve as OPFOR severely limit the scope of home-station force-on-force exercises. Exercise managers may position virtual OPFOR units off the installation for an attack against BLUFOR, rather than consuming limited maneuver space for live OPFOR assembly areas. Virtual OPFOR units consume no fuel, pyrotechnics, or repair parts, nor do they cause environmental damage. Virtual OPFOR may augment a live OPFOR by serving as second echelon maneuver forces and supporting units (i.e., OPFOR artillery). However, virtual OPFOR does pose tradeoffs the exercise planner must consider. Although a virtual OPFOR may alleviate the requirement for a live OPFOR, there is an increase in the TAF workload to control and direct the computer-generated force. Thermal sights will not acquire a virtual OPFOR that has no thermal signature. Radars cannot acquire a virtual OPFOR that has no mass. Virtual OPFOR will not stimulate IFF equipment. Development of a virtual OPFOR that emits an array of signatures to stimulate BLUFOR acquisition capabilities is required to provide a level of fidelity comparable to a live OPFOR.

Conclusions

Our study conclusions address:

- The extensibility of our analysis to other tactical systems
- The merit of the proposed strategies in reducing OC and TAF analyst workload
- The need for a TES and IS synergy to meet intrinsic and extrinsic feedback requirements

Representative Systems

As we analyzed the intrinsic and extrinsic feedback requirements imposed by force modernization initiatives, we identified 24 representative systems in which the analysis applied to 104 other systems (munitions, tactical systems, or technology demonstrations). The study also identifies 14 tactical systems which were special cases requiring a separate, unique analysis. The analysis supports a total of 142 systems/technology demonstrations.

Control and feedback requirements imposed by force modernization initiatives will overwhelm OCs and TAF analysts without a corresponding upgrade to tactical engagement simulation and instrumentation systems. We developed 13 strategies to reduce the burden on OCs and TAF analysts. Of the 380 OC and TAF analyst control and feedback tasks identified by the study, implementation of all strategies will result in full to partial workload reduction for 368 tasks (97 percent). Further study is required to determine the criticality, complexity, duration, and frequency of each task and the workload reduction required to permit OCs and TAF analysts to perform their intrinsic and extrinsic feedback functions effectively.

OC and TAF Analyst Workload Reduction

We reviewed all analysis results eliminating task duplication. There were occasions when an OC and TAF analyst performed different aspects of the same task. When this occurred we counted the task once for the OC and once for the TAF analyst. Our analysis of intrinsic and extrinsic feedback requirements for force modernization initiatives, AAR and THP preparations, and OC mentoring identified 380 distinct control and feedback tasks. The bar graphs that follow show the impact of the study's 13 strategies in reducing OC and TAF analyst workload based on the following criteria:

- Number of tasks fully eliminated by a strategy or combination of strategies
- Number of tasks in which a strategy or combination of strategies eliminates the majority of the tasks' requirements
- Number of tasks in which a strategy or combination of strategies eliminates some aspects of the tasks' requirements

Figure 63 shows the impact of each strategy on the reduction of OC workload. Of the 198 OC tasks we identified, implementation of all strategies will result in full to partial reduction of the workload on 188 tasks. This equates to a reduction in workload on 95 percent of the OC tasks identified by the study.

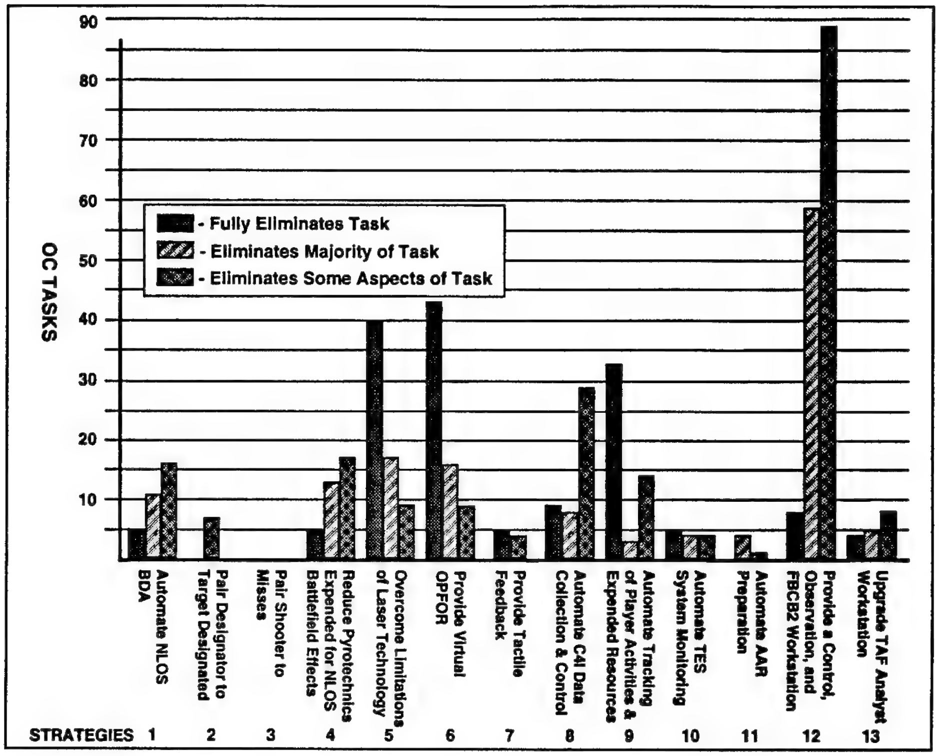


Figure 63. Crosswalk of strategies to OC workload reduction

Figure 64 shows the impact of each strategy on the reduction of TAF analyst workload. Of the 182 TAF analyst tasks we identified, implementation of all strategies will result in full to partial reduction of the workload on 180 tasks. This equates to a reduction in workload on 99 percent of the TAF analyst tasks identified by the study.

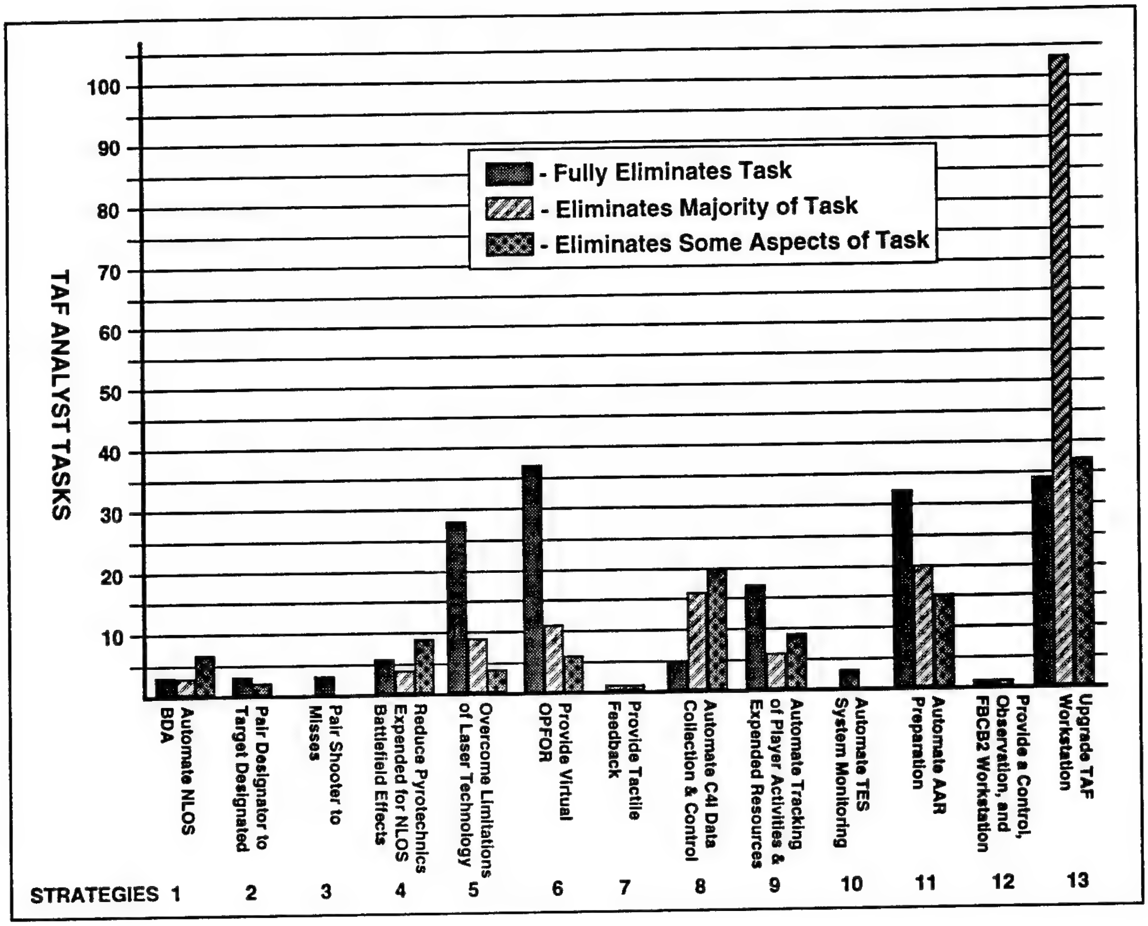


Figure 64. Crosswalk of strategies to TAF workload reduction

In Figure 65 we show the extent to which implementation of all strategies impact on OC and TAF analyst workload reduction for C4I, weapons, RSTA, AAR and THP, and coaching/mentoring control and feedback tasks. Of the 380 OC and TAF analyst tasks we identified, implementation of all strategies will result in full to partial reduction of the workload on 368 tasks. This equates to a reduction in workload on 97 percent of the OC and TAF analyst tasks identified by the study. See Appendix K for a spreadsheet that crosswalks each strategy to OC and TAF analyst tasks fully to partially eliminated.

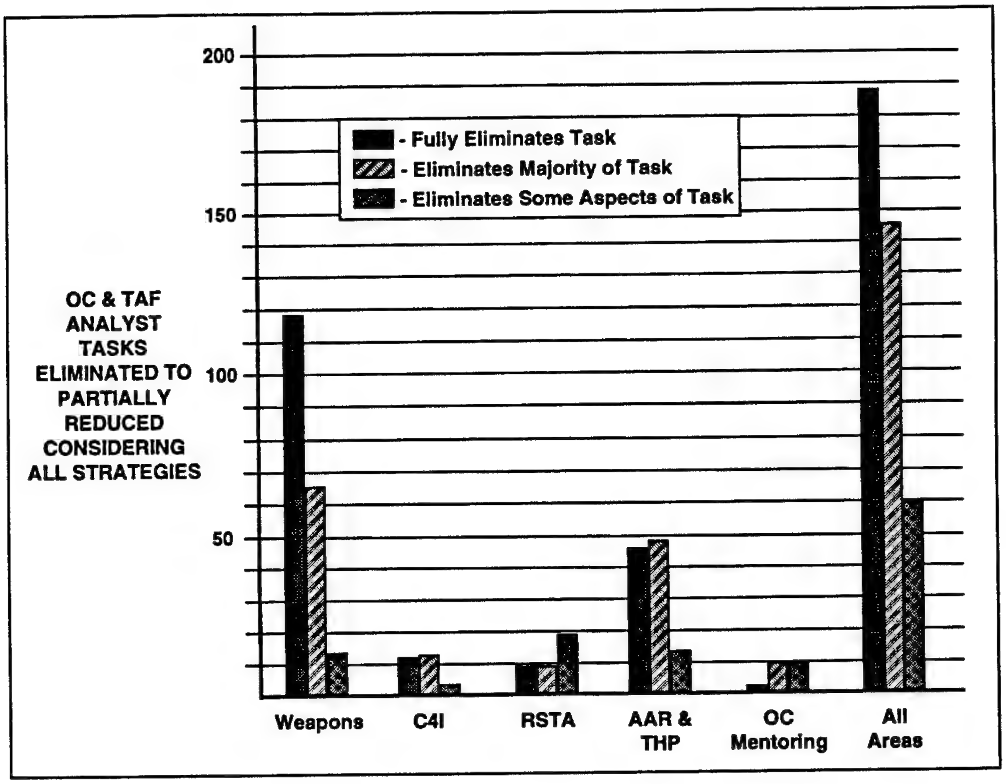


Figure 65. Crosswalk of strategies to OC and TAF workload reduction

Overcoming TES and IS Limitations

When we crosswalked our analysis of future intrinsic and extrinsic feedback requirements with the current state-of-the-art TES and IS capabilities, we identified--

- T-and I-Coded Items--feedback provided by the TES system and IS
- O-Coded Items--feedback provided by OC and TAF analyst control actions and data collection
- N-Coded Items--no feedback provided (TES system and IS capability limitations that neither the OC nor TAF analyst can reasonably overcome using manual procedures)

In Figure 66 we show the extent to which implementation of all strategies overcome TES and IS limitations (N-coded items) in providing intrinsic and extrinsic feedback for weapons, C4I, and RSTA systems. Our analysis identified 74 TES system and IS limitations. Figure 66 shows--

- Number of TES/IS limitations fully eliminated by the 13 strategies.

- Number of TES/IS limitations in which the strategies overcome the majority of the intrinsic and extrinsic feedback problems

- Number of TES/IS limitations in which the strategies overcome some aspects of the intrinsic or extrinsic feedback problems

Of the 74 TES system and IS limitations we identified, implementation of all strategies will result in full to partial elimination of 62 limitations (84 percent). See Appendix L for a spreadsheet that crosswalks each strategy to TES system and IS limitations fully to partially overcome.

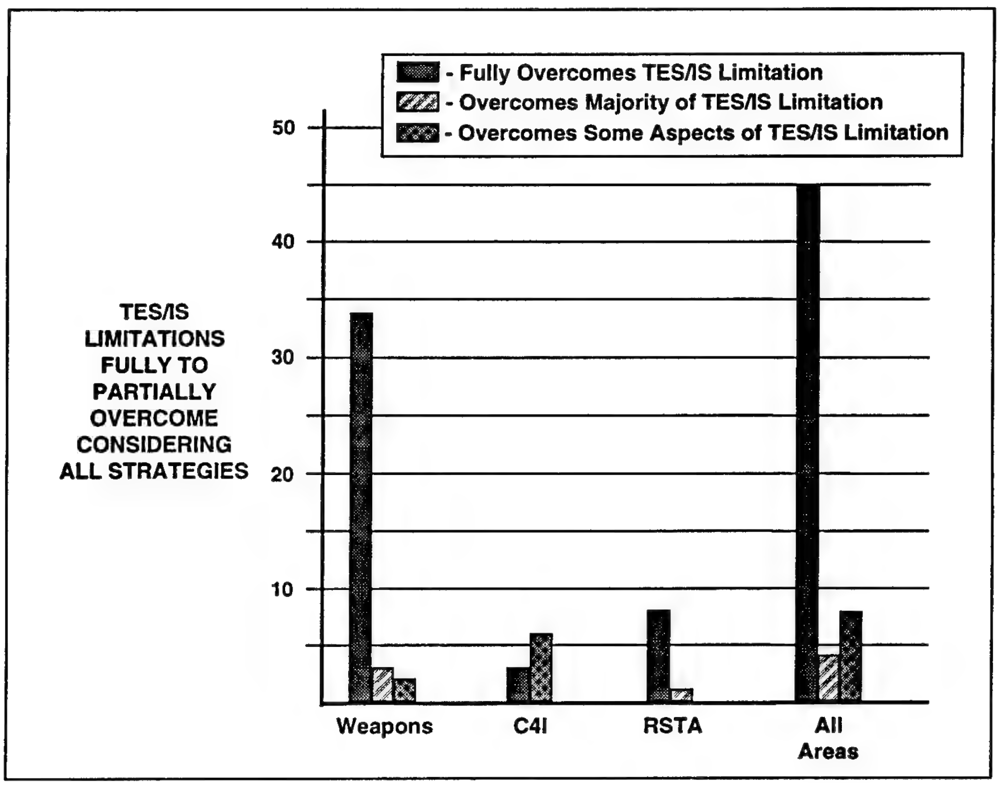


Figure 66. Crosswalk of strategies to TES and IS limitations eliminated

Control and feedback requirements imposed by force modernization initiatives will overwhelm OCs and TAF analysts without a corresponding upgrade to the TES and IS. Further study is required to determine if the workload reduction achieved by the 13 strategies is sufficient to permit OCs and TAF analysts to

perform their intrinsic and extrinsic feedback functions effectively.

TES/IS Synergy

There must be a synergy between the TES system and the IS to meet player intrinsic feedback requirements during the exercise and extrinsic feedback requirements for AARs, OC coaching, and unit THPs. Data produced by the TES system is needed by the IS to support AARs. IS data is needed by the TES system to support exercise control requirements and produce battlefield effects (flash and bang) and assess equipment damage and casualties.

Recommendations

Our recommendations discuss reuse of the TAAF Aids Database, expansion of the study's scope, modeling of TAAF Aids strategies, and a follow-on cost and training effectiveness analysis.

TAAF Aids Database

The Army should continue to populate and refine the design of the TAAF Aids database during future projects involving analysis of exercise control and training feedback functions. The basic structure of the Microsoft Access database will support analysis of any training simulation. The database provides a structured approach to analyze tactical systems for intrinsic and extrinsic feedback requirements based on the simulation's capabilities. The database supports identification of the following feedback sources:

- Feedback from real entities or activities
- Feedback from simulated entities or activities
    - -- Feedback provided by the simulation
    - -- Feedback provided by OC and TAF analyst control actions or data collection
    - -- Feedback voids

Examine the Live Fire Situation

The TAAF Aids study addresses control and feedback requirements for live training at the Bn TF level and below for force-on-force exercises. A similar analysis for live fire

force-on-force exercises. A similar analysis for live fire training will identify the intrinsic and extrinsic feedback requirements for ranges and targetry systems.

Modeling TAAF Aids Strategies

The study identifies OC and TAF analyst control and feedback tasks for Bn TF force-on-force exercises, provides a broad range of strategies to reduce workload, and measures the merit of each strategy in reducing manual tasks. However, the study does not provide sufficient information to determine which strategies to implement. Further study is needed to address the criticality, complexity, duration, and repetition of tasks identified by the TAAF Aids Study. Computer modeling can provide high resolution on the impact of TAAF Aids proposed strategies, support "what if" alternatives, and promote the generation and refinement of strategies.

Cost and Training Effectiveness Analysis

In our analysis, we identified the intrinsic feedback the soldier or crew will receive during actual employment of future combat systems. We contrasted our analysis results with the capabilities of the TES, IS, OCs, and TAF analysts to meet these feedback requirements. In many cases, we found that providing the feedback required intensive control actions. In some instances we found feedback voids. We do not recommend that the government develop IS and TES systems to provide intrinsic feedback on all the N-coded (no feedback) items or to completely eliminate the O-Coded (OC/TAF feedback) items in this report. We recommend a follow-on analysis to determine which N- and O-coded items are cost- and training-effective to implement in future IS and TES systems.

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APPENDIX A - LIST OF ABBREVIATIONS AND ACRONYMS

2D	Two Dimensional
3D	Three Dimensional
A2C2	Army Airspace Command and Control
AAR	after action review
ABCS	Army Battle Command System
ABMOC	Air Battle Management Operations Center
ABW	Acoustic Beam Weapon
ACUS	Area Common-User System
AD	Air Defense
ADDS	Army Data Distribution System
AFATDS	Advanced Field Artillery Tactical Data System
AGCCS	Army Global Command and Control System
AI	Artificial Intelligence
AIT	Automatic Identification Technology
AMPS	Air Mission Planning System
ARI	Army Research Institute
ART	Army Tactical Systems
ASAS	All Sources Analysis System
ATCCS	Army Tactical Command and Control System
ATM	Asynchronous Transfer Mode
ATSC	Army Training Support Center
AVD	Audio-Visual Devices
AWE	Advanced Warfighting Exercise
BDA	Battle Damage Assessment
BFA	Battlefield Functional Area
BFACS	Battlefield Functional Area Control Systems
BLUFOR	Friendly/rotating unit
BN	Battalion
BOS	Battlefield Operating System
C2	Command and Control
C4I	Command, Control, Communications, Computers, and Intelligence
CALL	Center for Army Lessons Learned
CASEVAC	Casualty Evacuation
CDR	Commander
CGF	Computer-Generated Force
CGS	Common Ground Sensor
CMTC	Combat Maneuver Training Center
CNN	Cable News Network
CNR	Combat Net Radio
COF	Control, Observation, and FBCB2
CP	Command Post
CSS	Combat Service Support
CSSCS	Combat Service Support Control System
CTC	Combat Training Center
CTIS	Combat Terrain Information System
CTSD	Combat Training Support Directorate
CVC	Combat Vehicle Crew

DAAS	Defense Automatic Addressing System
DFIRS	Deployable Field Instrumented Range System
DOW	Died of Wounds
DSS	Decision Support Systems
DSSU	Dismounted Soldier System Unit
DTOC	Division Tactical Operation Center
DTSS	Digital Topographic Support System
EBC	Echelons Corps and Below
E-FOGM	Enhanced Fiber Optic Guided Missile
EMCC	Exercise Management and Control Cell
ENDEX	End of the Exercise
EPLRS	Enhanced Position Location Reporting System
EPLRS-VHSIC	Enhanced Position Location Reporting System-Very
High Speed	Circuit
EW	Electronic Warfare
FA	Field Artillery
FAADC3I	Forward Area Air Defense Command, Control,
Computers, and	Intelligence
FAADS C2	Forward Area Air Defense System for Command and
Control	
FBCB2	Force XXI Battle Command Brigade and Below
FCR	Fire Control Radar
FDC	Fire Direction Center
FLI	Force Level Information
FS	Fire Support
GBS/BADD	Global Broadcast Service/Battlefield Awareness
and Data	Dissemination System
GCCS	Global Command and Control System
GCS	Ground Control Station
GSR	Ground Surveillance Radar
GTN	Global Transportation Network
HE	High Explosive
HTI	Home-station Training Instrumentation
IDS	Information Dissemination Server
IEW	Intelligence and Electronic Warfare
IFF	Identification Friend or Foe
IHFR	Improved High Frequency Radios
IMETS	Integrated Meteorological System
INC	Internet Controller
IS	Instrumentation System
IWEDA	Integrated Weather Effects Decision Aid
JRTC	Joint Readiness Training Center
JTAV	Joint Total Asset Visibility
JTF	Joint Task Force
JTIDS	Joint Tactical Information Distribution System
KIA	Killed in Action
LIPS	Logistics Information Processing System
LOS	Line of Sight
LZ	Landing Zone
MAIS	Mobile Automated Instrumentation Suite

MANPRINT	Manpower, Personnel, and Integration
MCS	Maneuver Control System
MCS/P	Maneuver Control System/Phoenix
METL	Mission Essential Task List
MILES	Multiple Integrated Laser Engagement System
MMW	Millimeter Wave
MOM	Map and Overlays Module
MSE	Mobile Subscriber Equipment
MSRT	Mobile Subscriber Radiotelephone Terminal
MTP	Mission Training Plan
MWLD	Man Worn Laser Detector
NCA	National Command Authority
NCS	Net Control Station
NLOS	Non-Line of Sight Engagements
NTC	National Training Center
OC	Observer/Controllers
OCCS	Observer Controller Communication System
OICW	Objective Individual Combat Weapon
OPFOR	Opposing Force
OPORD	Operations Order
ORD	Operational Requirements Documents
PDD	Player Detection Device
PK	Probability of Kill
PM TRADE	Project Manager Training Devices
PRIME	Precision Range Integrated Maneuver Exercise
RF	Radio Frequency
RFI	Radar Frequency Interferometer
RFI	Requests For Information
RSTA	Reconnaissance, Surveillance, and Target Acquisition
SA	Situational Awareness
SAWE	Simulated Area Weapons Effects
SAWE/MILES II	Simulated Area Weapons Effects/Multiple Integrated Laser Engagement System II
SDR	Surrogate Digital Radio
SID	Secondary Imagery
SINCGARS	Single Channel Ground and Airborne Radio System
SINCGARS SIP	SINCGARS Improvement Program
SME	Subject Matter Expert
SOP	Standard Operating Procedure
STAARS	Standard Army After Action Review System
STAFF	Smart Target Activated Fire and Forget
STARTEX	Start of the Exercise
STMCS	Stealth Trainer's C4I Monitoring System
TACSAT	Tactical Satellite
TAAF Aids	Training Analysis and Feedback Aids
TAF	Training Analysis Facility
TAV	Total Asset Visibility
TES	Tactical Engagement Simulation
TF	Task Force

THP	Take Home Package
TI	Tactical Internet
TMA	Tactical Movement Analyzer
TOC	Tactical Operation Center
TPN	Tactical Packet Network
TRADOC	US Army Training and Doctrine Command
UAV	Unmanned Aerial Vehicle
VDD	Vehicle Detection Device
VISMOD	Visually Modified
VMF	Variable Message Format
VTC	Video Teleconference
WAM	Wide Area Munition
WAN	Wide Area Network
WFA	Warfighter's Associate
WIA	Wounded In Action

APPENDIX B - BIBLIOGRAPHY

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APPENDIX C - REPRESENTATIVE SYSTEMS

1. The analysis supports 142 systems/technology demonstrations. As we analyzed the intrinsic and extrinsic feedback requirements of weapon, RSTA, and C4I systems, we found that our analysis of selected systems was applicable to other systems. For those systems where our analysis supported the control and feedback requirements of other tactical systems, we designated the analyzed system as a "representative system." The table in this appendix lists 24 representative systems and 104 other systems (munitions, tactical systems, or technology demonstrations) supported by our analysis of the representative systems.

When we could not extend the analysis of a system to other systems, we designated these systems--"special cases." Appendix C identifies 14 special cases where our analysis is pertinent only to the analyzed system.

Our analysis of representative systems and special cases appear in the illustrations in Appendix D (Weapon System Analysis), Appendix F (RSTA System Analysis), and Appendix H (C4I System Analysis).

2. The table in this appendix addresses munitions, tactical systems, and technology demonstrations using the following system groups:

- Mounted Forces
  - Line-of-Sight Weapons
  - Non-Line-of-Sight Weapons
- Close Combat Light
  - Line-of-Sight Weapons
  - Non-Line-of-Sight Weapons
  - Non-Lethal Weapons
- Aviation
  - Line-of-Sight Weapons
  - Non-Line-of-Sight Weapons
- Air Defense
- Fire Support
- C4I
  - ATCCS
  - FBCB2
- Engineer and Mine Warfare
  - Countermobility
  - Mobility
- Logistics
- RSTA
- Nuclear, Biological, Chemical (NBC)
- Hit Avoidance Obscurants

System Groups, Representative Systems, and Special Cases	Systems and Technology Demonstrations Supported by Representative System Analysis
Mounted Forces Line-of-Sight Weapons Representative System--Abrams Tank, Main Gun	 7.62 Cal Machine Gun .50 Cal Machine Gun, M2 Abrams Tank, Main Gun Armor-Piercing, Fin-Stabilized, Discarding Sabot, Tracer (APFSDS-T) Round, M829 High Explosive Anti-Tank Multipurpose (HEAT-MP), M830 Kinetic Energy Tungsten Core (KE-T) TERM-KE M1A3 Abrams Program (02-07) Bradley Fighting Vehicle, 25mm Cannon Direct Fire Lethality ATD (96-00) Armament Enhancement Initiative (AEI) (93-00) Direct Fire Lethality Program (99-01) Counter Active Protection Systems (CAPS) TD (96-99) Army Combined Arms Weapon System (TACAWS) TD (94-97 and 99-02)
Mounted Forces Non-Line-of-Sight Weapons Representative System--Abrams Tank, Main Gun, Smart Target Activated Fire and Forget (STAFF)	 Armament Enhancement Initiative (AEI) (93-00)
Close Combat Light Line-of-Sight Weapons Representative System—Objective Individual Combat Weapon (OICW)	 Rifle, M16A2 Grenade Launcher, M203 Squad Automatic Weapon (SAW), M249 40mm Grenade Machine Gun, MK19 Objective Crew-Served Weapon (OCSW) LAW, M72 Dragon, M203 Light Anti-tank Weapon, AT4 Javelin, Anti-Tank System Line of Sight Anti Tank (LOSAT) Multi-Purpose Individual Munition/Short Range Anti-Tank Weapons (MPIM/SRAW) Claymore Mine, M18A1
Representative System--Land Warrior System	Generation II Soldier
Special Case—Bayonet	

System Groups, Representative Systems, and Special Cases	Systems and Technology Demonstrations Supported by Representative System Analysis
Close Combat Light Non-Line-of-Sight Weapons Representative System-- Objective Individual Combat Weapon (OICW))	Objective Crew Served Weapon(OCSW)
Close Combat Light Non-Lethal Systems Representative System— 12-Gauge Round (Bean Bag) TD (96-98) Special Cases— High Power Acoustic Beam Weapon TD (92-96) Electric Water Cannon TD (94-97) Aqueous Foam Barrier TD (94-96)	Non-Lethal Entanglement TD (95-98) Mid-Sized Riot Control Dispenser TD (95-97) Non-Lethal Marker Munition TD (96-98)
Aviation Line-of-Sight Weapons Representative System-- Apache AH-64A HELLFIRE	Apache AH-64 A&D 30mm Chain Gun Apache AH-64A&D HYDRA 70 Rocket Apache AH-64A&D HELLFIRE II Apache AH-64D Longbow HELLFIRE Low-Cost Precision Kill (LCPK) 2.75-inch Guided Rocket TD (96-98) Army Combined Arms Weapon System (TACAWS) TD (94-97 and 99-02) Miniature Hypervelocity Kinetic Energy Missile (MIHKEM) TD (96-99)
Aviation Non-Line-of-Sight Weapons Representative System-- Apache AH-64D Longbow HELLFIRE	Apache AH-64A &D HELLFIRE Apache AH-64A &D HELLFIRE II

System Groups, Representative Systems, and Special Cases	Systems and Technology Demonstrations Supported by Representative System Analysis
Air Defense	
Representative System-- Avenger Air Defense System	Army Combined Arms Weapon System (TACAWS) TD (94-97 and 99-02) Stinger Linebacker Miniature Hypervelocity Kinetic Energy Missile (MIHKEM) TD (96-99) Chaparral Vulcan
Fire Support	
Representative System-- Crusader Howitzer	Self-Propelled Howitzers M109A1, A2, A3, A4, A5 M198, M102, M119 Towed Howitzers Paladin Howitzer High Mobility Artillery Rocket System HIMARS) TD (95-99) 155mm Lightweight Automated Howitzer (LAH) TD and Advanced Towed Cannon System (ATCAS) Technology Assessment (94-01) Search and Destroy Armor (SADARM) projectile Dual Purpose Improved Conventional Munition (DPICM) Rocket Assisted Projectile (RAP) Guided Multiple Launch Rocket System MLRS) ATD (95-98) Autonomous Intelligent Submunition (AIS) Damocles TD (94-97) Artillery Extended Range Cargo Projectile (AERCAP) TD (95-02) Low Cost Competent Munitions (LCCM) TD (95-98/02) Flame/Incendiary Munitions (00-01) Combustion Engine Defeat Mechanism TD (96-97)
Representative System-- Precision Guided Mortar Munition, 120mm (PGMM)	Copperhead projectile
Special Case-- Enhanced Fiber Optic Guided-Missile (EFOG-M)	

System Groups, Representative Systems, and Special Cases	Systems and Technology Demonstrations Supported by Representative System Analysis
Nuclear, Biological, Chemical (NBC)	
Smoke Representative System--Smoke Generator, M56	Mechanized Smoke Generator-Wolf, M58 Multispectral Demonstration (04-06) Millimeter Wave Screening (97-98)
Chemical Representative System--Multipurpose Integrated Chemical Agent Alarm (MICAD)	Joint Service Warning and Identification LIDAR Detector (JSWILD) (96-97) Joint Service Chemical Miniature Agent Detector (JSCMAD) (98-01) Advanced Filtration Concepts Demonstration (98-99)
Biologicial Representative System--Biological Integrated Detection System (BIDS)	Joint Biological Point Detection System (JBPDS)
Decontamination Model	Chemical Biological Decontamination Demonstration (99-01)
Hit Avoidance Obscurants	
Representative System--Multispectral Demonstration (04-06)	Light Vehicle Obscuration System (LVOSS) Multi-Spectral Countermeasures (MSCM) TD (97-99) Hit Avoidance ATD (95-98) Full Spectrum Threat Protection TD (00-04)
Engineer and Mine Warfare Countermobility	
Representative System—RAPTOR-Intelligent Combat Outpost	Hand Emplaced Wide Area Munition (WAM), M93 Electric Vehicle Stopper TD (94-97) Ground-Emplaced Mine Scattering System (GEMMS) Modular Pack Mine System (MOPMS) Area Denial Artillery Munition (ADAM) Remote Anti-Armor Mine (RAAM) Shielder Anti-Tank System Anti-Tank Mine, M21 Anti-Personnel Mine, M14 Anti-Personnel Mine, M16A1
Special Case--Volcano Multiple Delivery Mine System	

System Groups, Representative Systems, and Special Cases	Systems and Technology Demonstrations Supported by Representative System Analysis
Engineer and Mine Warfare Mobility Representative System--Off Road Smart Mine Clearance (ORSMC)	Vehicular Mounted Mine Detector ATD (94-97) Mine Hunter Killer Technology Demonstration (98-00)
Reconnaissance, Surveillance, and Target Acquisition (RSTA) Representative Counterbattery Radar--Firefinder Q36	Firefinder Q37
Representative Ground Surveillance Radar (GSR)--AN/PPS-5	SAR Target Recognition and Location System (STARLOS) (94-99) Moving-Target-Locating Radar (MTLR) AN/TPS-25A MTLR AN/TPS-58B GSR AN/PPS-15 Platoon Early Warning System (PEWS)
Representative Identification Friend or Foe System--Battle Combat Identification System (BCIS)	Battlefield Combat Identification(BCID) Combat Identification for the Dismounted Soldier (CIDS) Demonstration (93-98)
Representative Unmanned Reconnaissance Vehicle—Maneuver Unmanned Aerial Vehicle (UAV)	Hunter UAV Autonomous Scout Rotorcraft Testbed (ASRT) TD (94-96) Machine Vision for Autonomous Unmanned Ground Vehicle (UGV) TD (96-99) Aerial Scout Sensor Integration Technology Demonstration (95-98) Multi-Mission UAV (MMUAV) Payload (97-00)
Representative Sensor Platform--Hunter Sensor Suite	Long Range Advanced Scout Surveillance System (LRAS3) Multi-Function Sensor Suite (MFSS) (98-01) Air/Land Enhanced Reconnaissance and Targeting (ALERT) ATD (97-00) Remote Sentry ATD (93-96)
Representative Air Defense Sensor--FAAD Ground Based Sensor	Electronic Integrated Sensor Suite for Air Defense (EISS-AD) (94-97)

System Groups, Representative Systems, and Special Cases	Systems and Technology Demonstrations Supported by Representative System Analysis
Reconnaissance, Surveillance, and Target Acquisition (RSTA) (cont.) Special Cases-- Bird Dog UAV Remotely Monitored Battlefield Sensor System (REMBASS)	
Command, Control, Communications, Computers, and Intelligence (C4I) Systems Special Cases-- Maneuver Control System (MCS) All Source Analysis System (ASAS) Advanced Field Artillery Tactical Data System (AFATDS) Forward Area Air Defense System Command and Control (FAADS C2) Combat Service Support Control System (CSSCS) Force XXI Battle Command, Brigade and Below (FBCB2)	

APPENDIX D - WEAPONS SYSTEMS

Introduction
WEAPONS Systems Analysis

As we analyzed the intrinsic and extrinsic feedback requirements of weapon, RSTA, and C4I systems, we found that our analysis of selected systems was applicable to other systems. For those systems where our analysis supported the control and feedback requirements of other tactical systems, we designated the analyzed system as a "representative system." Appendix C lists 24 representative systems and 104 other systems (munitions, tactical systems, or technology demonstrations) supported by our analysis of the representative systems.

When we could not extend the analysis of a system to other systems, we designated these systems, "special cases." Appendix C identifies 14 special cases where our analysis is pertinent only to the analyzed system. The analysis supports a total of 142 systems/technical demonstrations.

Our analysis of representative systems and special cases for WEAPONS systems appear in the illustrations in this appendix. There are four types of one or more illustrations for each system. The first type of illustration, Intrinsic Feedback, identifies the "downrange" intrinsic feedback required during the exercise as players interact with their tactical systems and other players. Intrinsic feedback consists of those real or simulated entities or activities that stimulate the senses of the players (sight, sound, smell, feel, and taste) and cause them to react to a condition or combination of conditions. In our analysis, we identified not only the intrinsic feedback required, but also the source of the feedback. Each Intrinsic Feedback illustration contains a legend (Figure D-1) which identifies the feedback source.

P -- Actual feedback obtained by the players from hands-on interaction with their tactical equipment or other players

T -- Simulated feedback provided by the TES

O -- Simulated feedback provided by OCs and TAF analysts (includes firemarkers)

N -- No feedback provided

N = No Feedback
T = TES Feedback
O = OC/TAF Feedback
P = Player Hands-On Feedback

Figure D-1. Intrinsic feedback legend

The second type of illustration, Intrinsic Feedback Tasks, identifies OC or TAF analyst tasks required to provide "downrange" control actions to satisfy the "O" items shown on the Intrinsic Feedback illustrations.

The third type of illustration, Extrinsic Feedback, identifies the feedback provided to the BLUFOR in the form of AARs, coaching, and THPs. Our analysis of extrinsic feedback also identified feedback requirements and the source of the feedback. Each Extrinsic Feedback illustration in the appendix contains a legend (Figure D-2) which identifies the feedback source.

I -- Data collected by the instrumentation system

O -- Data collected by OCs or TAF analysts

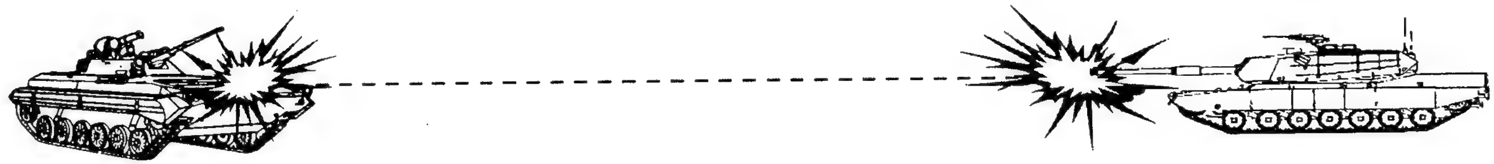
N -- Data not collected

N = No Feedback
I = Instrumented Feedback
O = OC/TAF Feedback

Figure D-2. Extrinsic feedback legend

The final type of illustration, Extrinsic Feedback Tasks, identifies OC and TAF analyst tasks required to capture the extrinsic data identified as "O" items on the Extrinsic Feedback illustrations.

Intrinsic Feedback: Abrams Tank Main Gun (LOS)



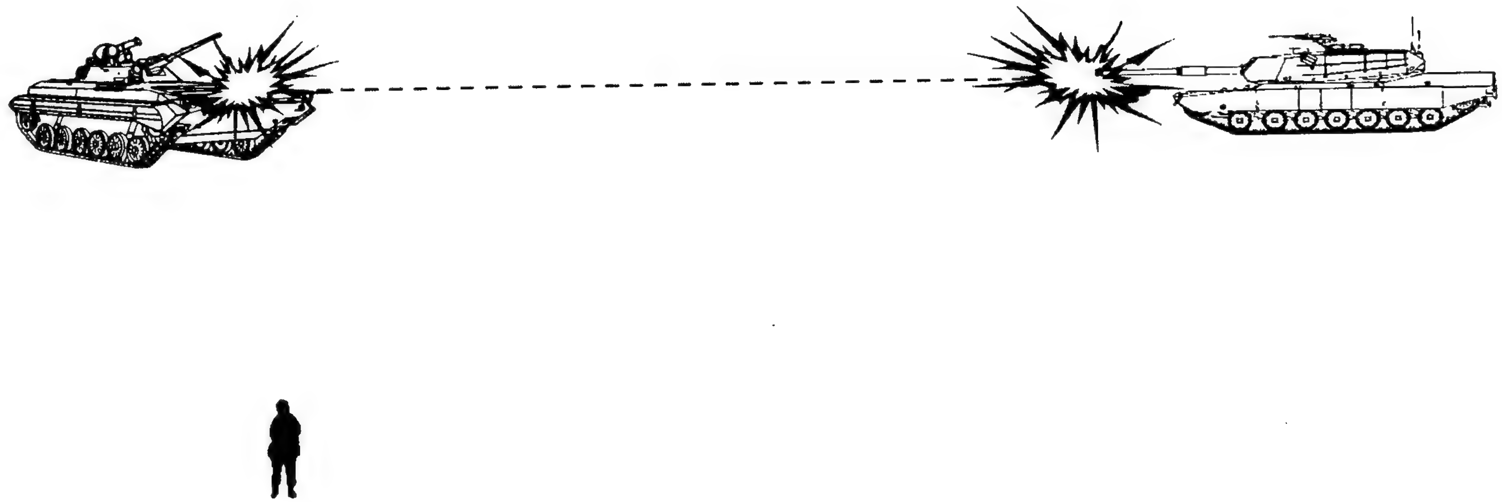
T - Visual signature of weapon shooting
T - Visual/audible indication of impacting ordnance (direct hits only)
T - Visual/audible indication of Near Miss
T - Out of action for MILES engagements
O - Out of action for control gun assessments
Visual/audible indication of ordnance effects:
- T - Fully operational
- T - Catastrophic kill
- T - Mobility kill
- T - Firepower kill
- T - Communications kill
- P - Type combat damage

P - Visual means to ID friendly and enemy
T - Visual/audible signature when fires
Visual indication of ordnance effects
- P - Catastrophic kill
- P - Mobility kill
- P - Firepower kill

T - Location of impacting ordnance (direct hits only)
N - Pairing of shooter to MISSES

N = No Feedback
T = TES Feedback
O = OC/TAF Feedback
P = Player Hands-On Feedback

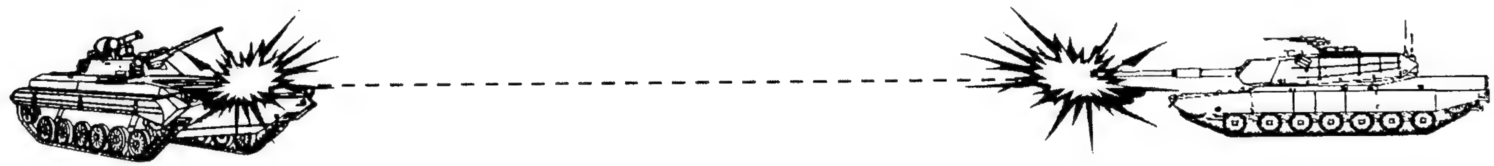
Intrinsic Feedback Tasks: Abrams Tank Main Gun (LOS)



CO Tank OC

1. Assess battle damage for rules of engagement (ROE) violations
2. Assess battle damage for inoperative MILES
3. Assess battle damage for MILES limitations:
   "MILES Berms"
   "Leaf Defilade"
   "Canvas Defilade"

Extrinsic Feedback: Abrams Tank Main Gun (LOS)



I - Victim ID
I - Victim location
Victim status:
- I - Fully operational
- I - Catastrophic kill
- I - Mobility kill
- I - Firepower kill
- I - Communications kill
- O - Type combat damage

I - Hit/Kill aspect angle

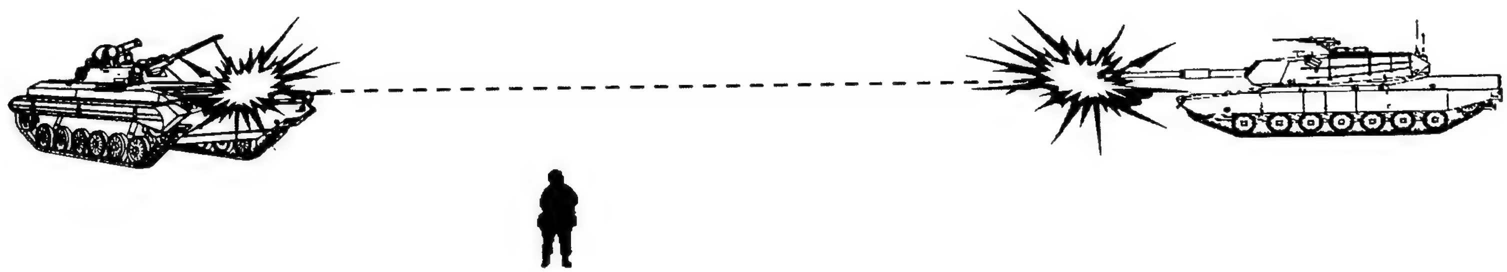
I - Shooter ID
I - Shooter location
I - Pairing of shooter to victim for MILES engagements
I - Location of shooter and victim when inter-visible and exposure time
I - Shooter's ranging capability
O - Pairing of shooter to victim for control gun assessments
N - Ammunition type and amount on hand
N - Ammunition type fired and amount
N - Pairing of shooter to MISSES
N - Turret orientation

N = No Feedback
I = Instrumented Feedback
O = OC/TAF Feedback

Extrinsic Feedback Tasks: Abrams Tank Main Gun (LOS)

CO TANK TAF Analyst

1. Record manual and instrumented battle damage assessments received from OC



CO Tank OC

1. Record type combat damage for MILES engagements
2. Record shooter and victim ID, for control gun assessments
3. Record battle damage for rules of engagement (ROE) violations
4. Record battle damage for inoperative MILES
5. Record battle damage for MILES limitations (MILES Berms, Leaf Defilade, Canvas Defilade)
6. Inform TAF analyst of results

For the results of the analysis for additional weapon systems, please:

- o see the "New Products" section of the ARI Home Page (htp:/198.97.199.12) and select TAAF-Aids to download Appendix D

or

- o contact the U.S. Army Research Institute for the Behavioral and Social Sciences

APPENDIX E - WEAPONS DATABASE

APPENDIX E - WEAPONS DATABASE

Introduction
WEAPON SYSTEMS DATABASE INFORMATION

Appendix E is a report printed from the Weapons section of the database. It includes the data from all of the Weapon systems that we have analyzed.

All of the information about each system appears together in the report. Each Weapon system has three main sections:

(1) The System Title Pages. This section contains the name of the system, a brief description of the system, the BOS/ART its associated with, details about the use of the weapon, and a description of the player engagement process.
(2) The Intrinsic Information Pages. This section contains both the intrinsic feedback requirements and the OC and TAF Analyst control tasks for that system.
(3) The Extrinsic Information Pages. This section contains both the extrinsic feedback requirements and the OC and TAF Analyst data collection tasks.

Each Weapon system has at least three pages associated with it. If a section's information does not fit completely on one page, the report will add an additional page for that section. In most cases, additional pages will contain trainer tasks. All trainer tasks are easily identifiable by their gray backgrounds. Regardless of the total number of pages per system, the organization is always the same (System Title Pages, Intrinsic Information Pages, and Extrinsic Information Pages). See Figure E-1 for an illustration of the groupings and the information contained with each Weapon system.

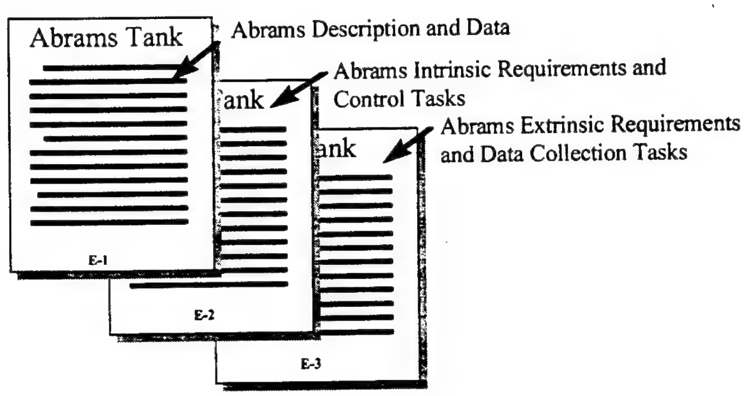


Figure E-1. Organization of appendix E

WEAPON SYSTEMS

SYSTEM NAME 12 Gauge Round (Bean Bag Ammunition)

NOMENCLATURE Non-Lethal Weapon

DESCRIPTION

The use of the 12 gauge shotgun is being modified to dispense various rounds for use as non-lethal weapons. The shotgun weapon is used by dismounted soldiers and the Military Police. The Bean Bag round is a projectile that is intended to be used as a direct fire weapon. The round is effective against individually selected targets. The round is also effective in engaging antagonists targets who are NOT ARMED and are showing an intention to aggression and violent behavior. The weapon is effective in dispersing large crowds in riot situations. It can also be used in any civil disturbance situation. The effective range of the weapon is 50 to 150 feet.

BOS/ART C2

✓ GROUND-TO-GROUND _ GROUND-TO-AIR _ AIR-TO-AIR ✓ TRACKING

_ AIR-TO-GROUND LOS/NLOS LOS _ FIRE-AND-FORGET

PLAYER/SYSTEM ENGAGEMENT PROCESS

The 12 gauge shotgun is a line of sight weapon. The operator sights the weapon and shoots at the target as required.

TES/IS USED MILES II; Line of Sight; Gnd-Gnd

SYSTEM NAME 12 Gauge Round (Bean Bag Ammunition)

WEAPON SYSTEM INTRINSIC FEEDBACK REQUIREMENTS

INTRINSIC FEEDBACK FROM SYSTEM OPERATION

Shooter needs:

Visual means to ID friendly and antagonist.
Ammunition type fired.
Visual indication of effects on antagonist:
  Combat effective.
  Out of action.

Victim needs:

Visual signature of weapon shooting.
Visual/audible indication of ordnance effects:
  WIA (Type wounds).

TES/IS PROVIDED INTRINSIC FEEDBACK

Shooter needs:

Visual/audible signature when fires.

Victim needs:

Visual/audible indication of impacting ordnance (direct hits only).
Audible indication of Near Miss.
Visual/audible indication of ordnance effects:
  Combat effective.
  Out of action for MILES engagements.

TRAINER PROVIDED INTRINSIC FEEDBACK

Victim needs:

Out of action indication for control gun assessments.
Battle damage assessments for inoperative MILES, MILES limitations, and Rules of Engagement (ROE) violations.

TES/IS INTRINSIC LIMITATIONS

Shooter needs:

Location of impacting ordnance (other than direct hits)

Victim needs:

Indication of type ordnance fired.
Visual indication of impacting ordnance (other than direct hits).

WEAPON SYSTEM TRAINER CONTROL TASKS

DUTY POSITION	PLT and CO/TM OC
LOCATION	Player location
TASK DESCRIPTION	Assess casualties for close in engagements (less than ten meters). Assess casualties for rules of engagement (ROE) violations. Assess casualties for inoperative MILES.

SYSTEM NAME 12 Gauge Round (Bean Bag Ammunition)

Assess casualties for MILES limitations:
- MILES Berms
- Leaf Defilade
- Canvas Defilade

SYSTEM NAME 12 Gauge Round (Bean Bag Ammunition)

WEAPON SYSTEM EXTRINSIC FEEDBACK REQUIREMENTS

TES/IS PROVIDED EXTRINSIC DATA

Shooter data:

Shooter ID.
Shooter location.
Pairing of shooter to victim for MILES engagements.

Victim data:

Victim ID.
Victim location.
Victim status:
  Combat effective.
  Out of action.

TRAINER PROVIDED EXTRINSIC DATA

Shooter data:

Pairing of shooter to victim for control gun kills.

Victim data:

Victim status:
  WIA (Type wounds).

UNATTAINABLE DATA

Shooter data:

Pairing of shooter to MISSES.
Ammunition type and amount on hand.
Ammunition type fired and amount.
Location of shooter and victim when inter-visible and exposure time.

WEAPON SYSTEM TRAINER DATA COLLECTION TASKS

DUTY POSITION	MVR OC
LOCATION	Player location
TASK DESCRIPTION	Record type wounds for WIA assessment. Record shooter and victim ID, for control gun assessments. Record casualties for close-in engagements (less than 10 meters). Record casualties for rules of engagement (ROE) violations. Record casualties for inoperative MILES. Record casualties for MILES limitations (MILES Berms, Leaf Defilade, Canvas Defilade). Inform TAF analyst of results.

SYSTEM NAME 12 Gauge Round (Bean Bag Ammunition)

DUTY POSITION MVR Analyst

LOCATION TAF

TASK DESCRIPTION Record manual and instrumented battle casualty assessments received from OC.

To obtain the complete Weapon System Analysis database, please:

- o see the "New Products" section of the ARI Home Page(htp:/198.97.199.12) and select TAAF-Aids to download Appendix E

or

- o contact the U.S. Army Research Institute for the Behavioral and Social Sciences

APPENDIX F - RSTA SYSTEMS ANALYSIS

Introduction
RSTA Systems Analysis

As we analyzed the intrinsic and extrinsic feedback requirements of weapon, RSTA, and C4I systems, we found that our analysis of selected systems was applicable to other systems. For those systems where our analysis supported the control and feedback requirements of other tactical systems, we designated the analyzed system as a "representative system." Appendix C lists 24 representative systems and 104 other systems (munitions, tactical systems, or technology demonstrations) supported by our analysis of the representative systems.

When we could not extend the analysis of a system to other systems, we designated these systems, "special cases." Appendix C identifies 14 special cases where our analysis is pertinent only to the analyzed system. The analysis supports a total of 142 systems/technology demonstrations.

Our analysis of representative systems and special cases for RSTA systems appear in the illustrations in this appendix. There are four types of one or more illustrations for each system. The first type of illustration, Intrinsic Feedback, identifies the "downrange" intrinsic feedback required during the exercise as players interact with their tactical systems and other players. Intrinsic feedback consists of those real or simulated entities or activities that stimulate the senses of the players (sight, sound, smell, feel, and taste) and cause them to react to a condition or combination of conditions. In our analysis, we identified not only the intrinsic feedback required, but also the source of the feedback. Each Intrinsic Feedback illustration contains a legend (Figure F-1) which identifies the feedback source.

- P – Actual feedback obtained by the players from hands-on interaction with their tactical equipment or other players
- T – Simulated feedback provided by the TES
- O – Simulated feedback provided by OCs and TAF analysts (includes firemarkers)
- N – No feedback provided

N = No Feedback
T = TES Feedback
O = OC/TAF Feedback
P = Player Hands-On Feedback

Figure F-1. Intrinsic feedback legend

The second type of illustration, Intrinsic Feedback Tasks, identifies OC or TAF analyst tasks required to provide "downrange" control actions to satisfy the "O" items shown on the Intrinsic Feedback illustrations.

The third type of illustration, Extrinsic Feedback, identifies the feedback provided to the BLUFOR in the form of AARs, coaching, and THPs. Our analysis of extrinsic feedback also identified feedback requirements and the source of the feedback. Each Extrinsic Feedback illustration in the appendix contains a legend (Figure F-2) which identifies the feedback source.

I – Data collected by the instrumentation system

O – Data collected by OCs or TAF analysts

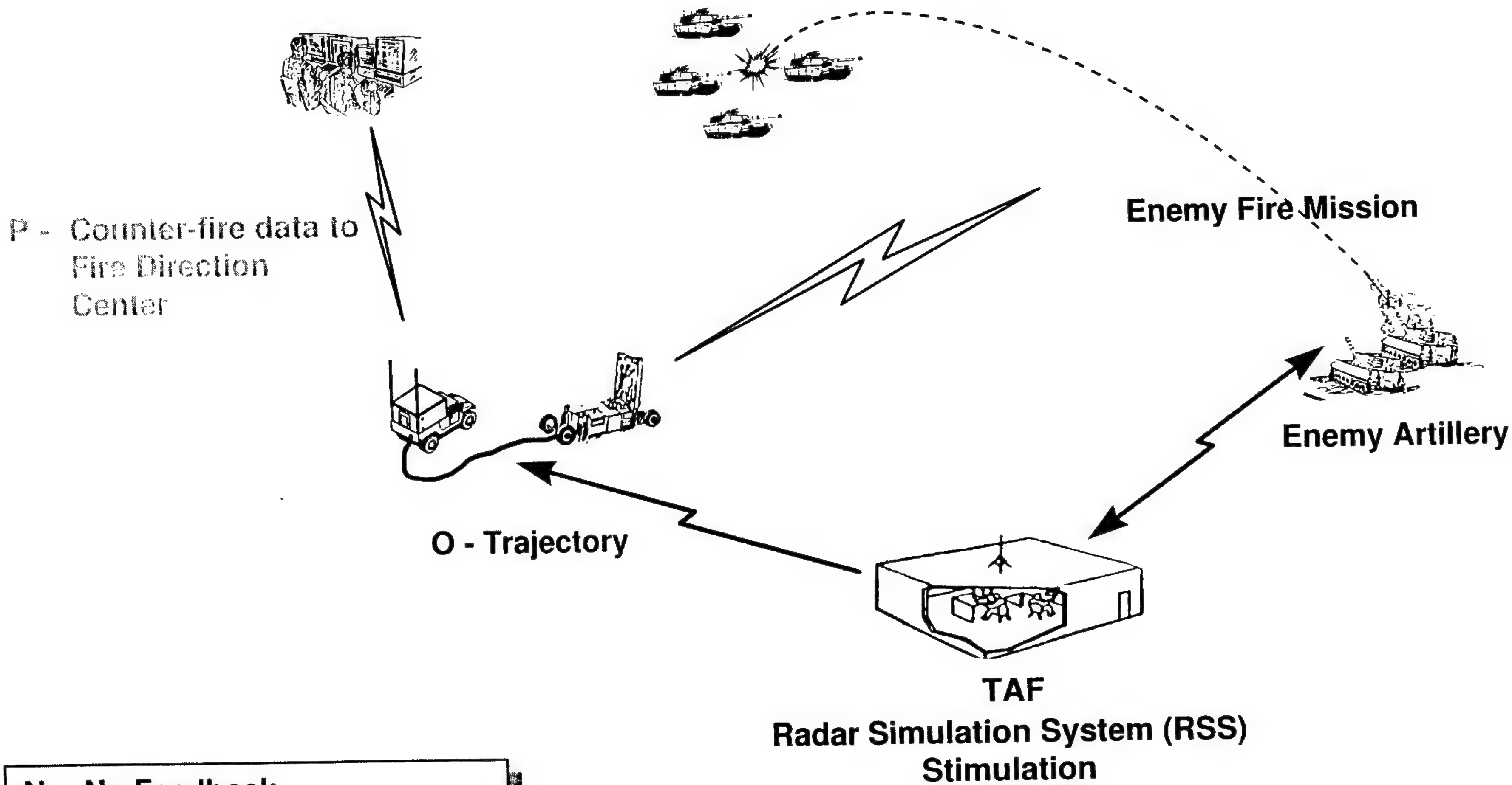
N – Data not collected

N = No Feedback
I = Instrumented Feedback
O = OC/TAF Feedback

Figure F-2. Extrinsic feedback legend

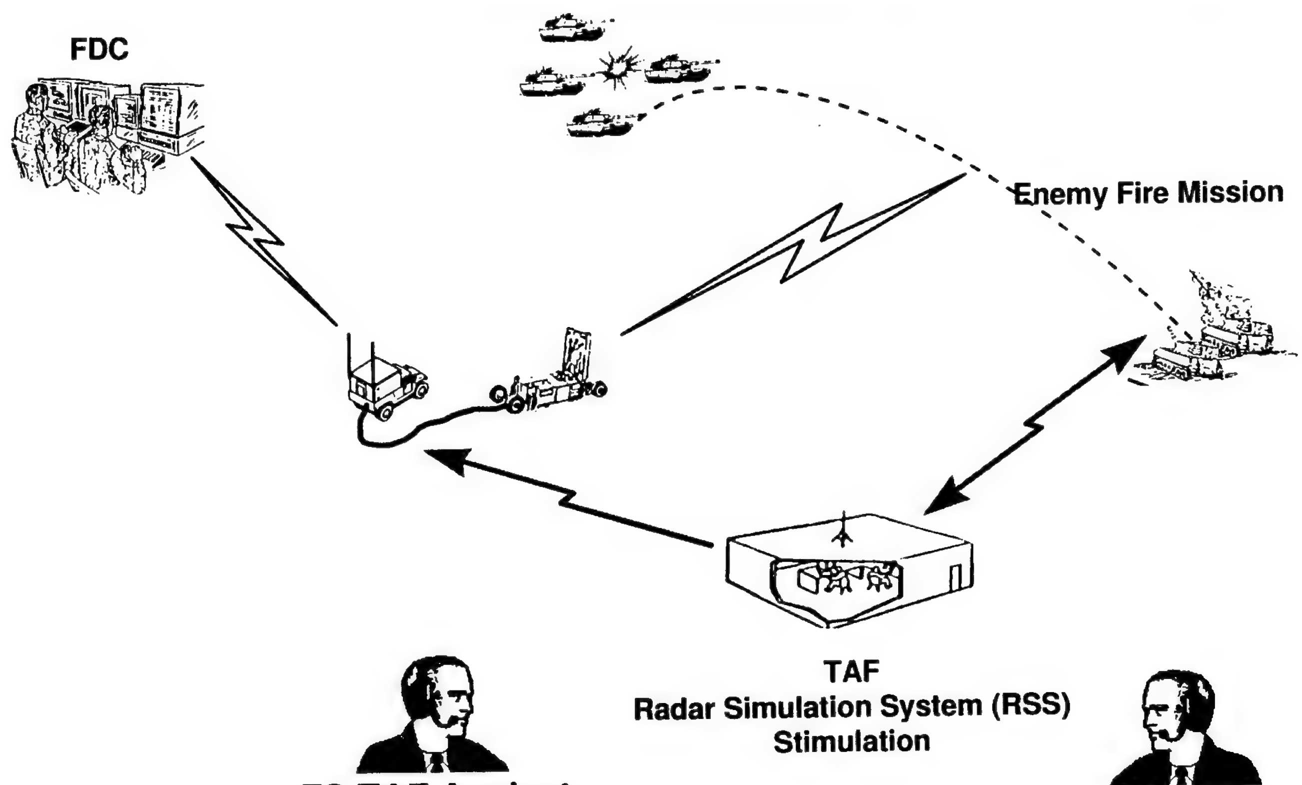
The final type of illustration, Extrinsic Feedback Tasks, identifies OC and TAF analyst tasks required to capture the extrinsic data identified as "O" items on the Extrinsic Feedback illustrations.

Intrinsic Feedback: FireFinder



N = No Feedback
T = TES Feedback
O = OC/TAF Feedback
P = Player Hands-On Feedback

Intrinsic Feedback Tasks: FireFinder



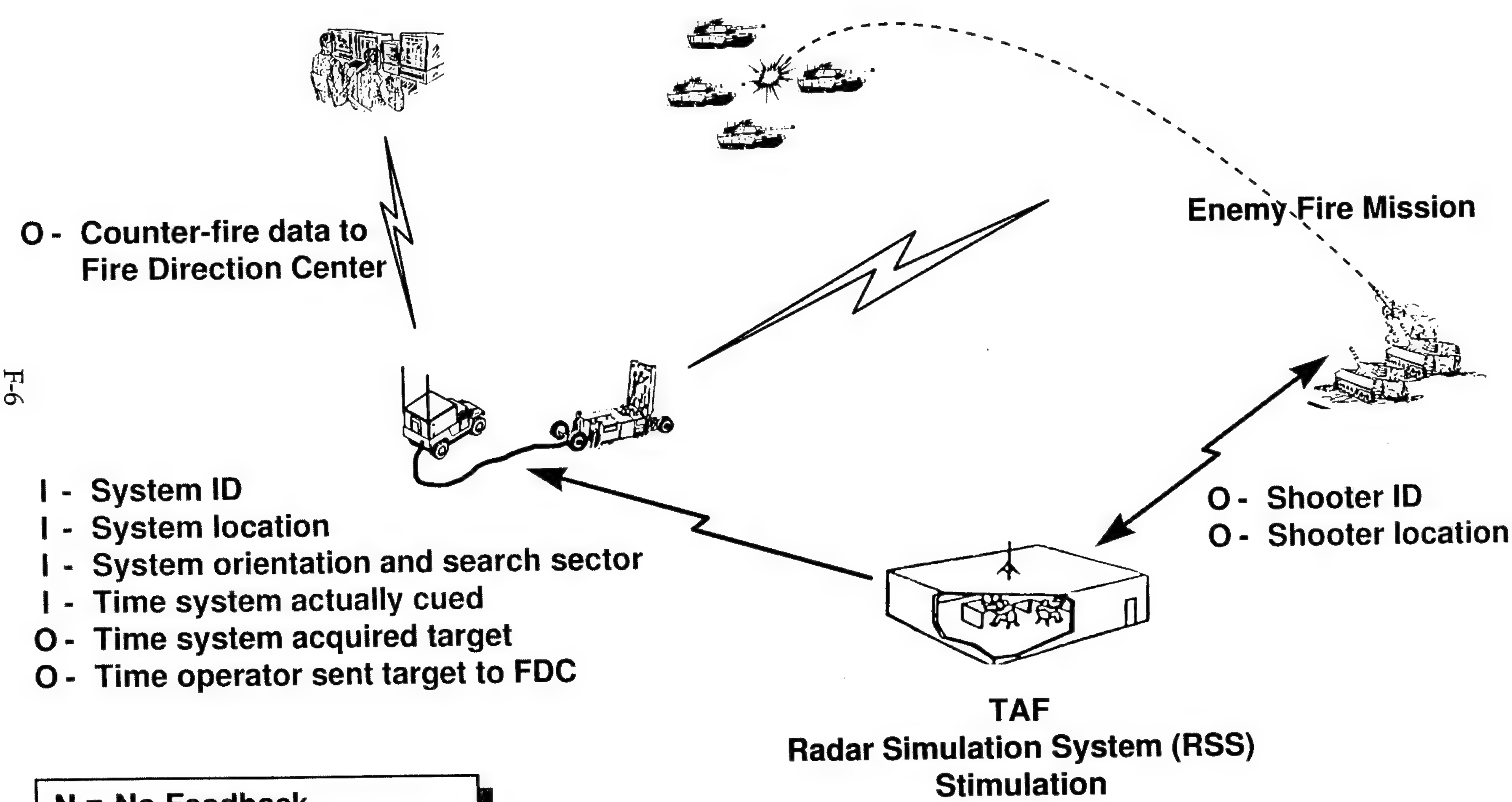
FS TAF Analyst
(RSS Operator)

1. Record OPFOR firing unit ID, unit location, and impact location received from another FS TAF Analyst
2. Process the data using the RSS to stimulate BLUFOR FireFinder radars.

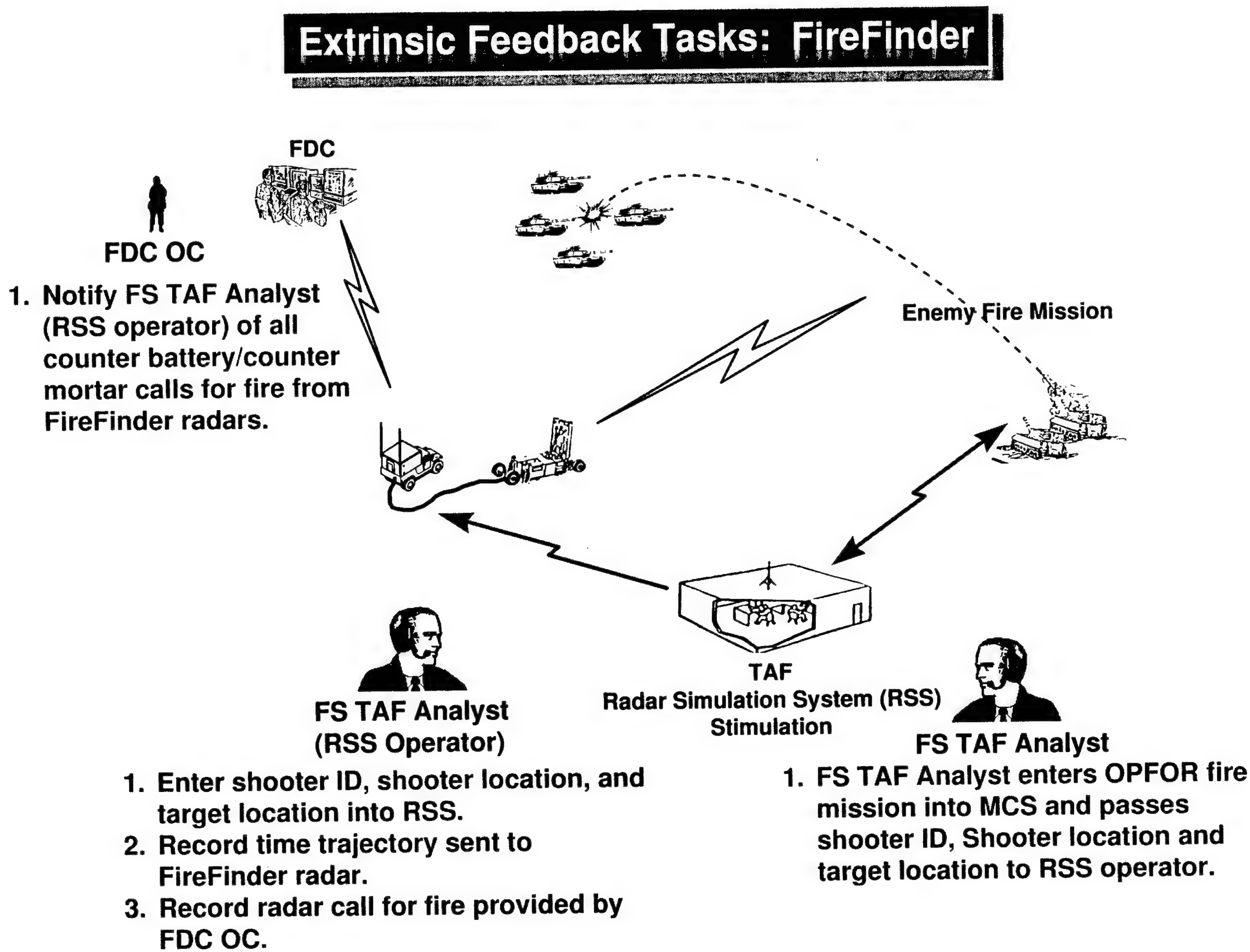
FS TAF Analyst

1. Record and process requested OPFOR artillery and mortar fire missions.
2. Pass the firing unit ID, unit location, and impact location to the RSS operator to process for acquisition by BLUFOR FireFinder radars.

Extrinsic Feedback: FireFinder



N = No Feedback
I = Instrumented Feedback
O = OC/TAF Feedback


Extrinsic Feedback Tasks: FireFinder
FDC
FDC OC
1. Notify FS TAF Analyst (RSS operator) of all counter battery/counter mortar calls for fire from FireFinder radars.
Enemy Fire Mission
TAF
Radar Simulation System (RSS)
Stimulation
FS TAF Analyst
(RSS Operator)
1. Enter shooter ID, shooter location, and target location into RSS.
2. Record time trajectory sent to FireFinder radar.
3. Record radar call for fire provided by FDC OC.
FS TAF Analyst
1. FS TAF Analyst enters OPFOR fire mission into MCS and passes shooter ID, Shooter location and target location to RSS operator.

For the results of the analysis for additional RSTA systems, please:

o see the "New Products" section of the ARI Home Page (htp:/198.97.199.12) and select TAAF-Aids to download Appendix F

or

o contact the U.S. Army Research Institute for the Behavioral and Social Sciences

APPENDIX G - RSTA SYSTEM DATABASE INFORMATION

Introduction

RSTA SYSTEM DATABASE

Appendix G is a report printed from the RSTA section of the TAAF Aids database. It includes the data from all of the RSTA systems that we have analyzed.

All of the information about each system appears together in the report. Each RSTA system has three main sections:

(1) The System Title Pages. This section contains the name of the system, a brief description of the system, sensor input, and sensor output.
(2) The Intrinsic Information Pages. This section contains both the intrinsic feedback requirements and the OC and TAF Analyst control tasks for that system.
(3) The Extrinsic Information pages. This section contains both the extrinsic feedback requirements and the OC and TAF Analyst data collection tasks.

Each RSTA system has at least three pages associated with it. If a section's information does not fit completely on one page, the report will add an additional page for that section. In most cases, additional pages will contain trainer tasks. All trainer tasks are easily identifiable by their gray backgrounds. Regardless of the total number of pages per system, the organization is always the same (System Title Pages, Intrinsic Information Pages, and Extrinsic Information Pages). See Figure G-1 below for an illustration of the groupings and the information contained with each RSTA system.

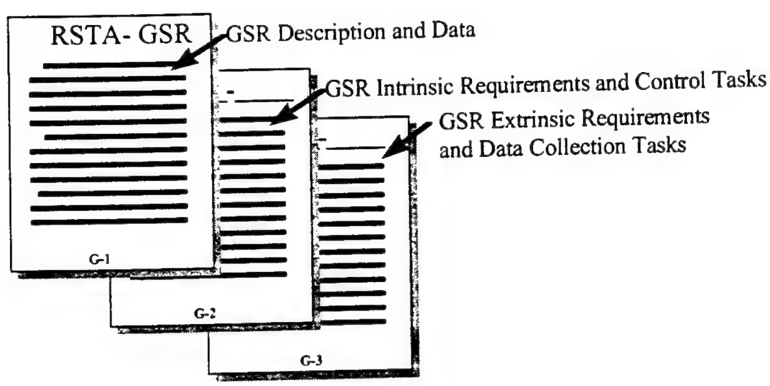


Figure G-1. Organization of Appendix G

RSTA SYSTEMS

SYSTEM NAME AN/TPS-58B Moving Target Locating Radar (MTLR)

NOMENCLATURE AN/TPS-58B

DESCRIPTION

The AN/TPS-58B is a lightweight, mobile, coherent Doppler radar. A coherent Doppler radar generates its own reference signal to detect moving targets. The mission of the MTLRs is to detect, identify, locate, and track moving ground targets accurately enough for attack by friendly weapons The section also can vector friendly patrols to specified areas.

BOS/ART FIREPOWER

TES/IS USED NONE

SENSOR DATA INPUT

The AN/TPS-58B requires electronic line of sight to the moving target. The AN/TPS-58B locates and tracks targets by changes in the frequency of the return signal produced by movement of the targets. The specific audio return of a target enables the radar operator to identify it as personnel, a light or heavy wheeled vehicle, or a tracked vehicle. It can locate moving personnel at ranges between 300 and 10,000 meters and vehicles between 300 and 20,000 meters to an accuracy of 50 meters. The AN/TPS-58B can automatically track moving targets and predict their future location.

SENSOR DATA OUTPUT

Target identification, Target location, Direction, and speed of both vehicles and personnel.

PLAYER/SYSTEM OPERATION PROCESSES

Radar operator inputs search parameters as required.
Radar operator turns the transmitter on when directed (cued)
Radar operator processes targets as they are located.
Operator transmits target locations to supported unit as directed.

SYSTEM NAME AN/TPS-58B Moving Target Locating Radar (MTLR)

RSTA SYSTEM INTRINSIC FEEDBACK REQUIREMENTS

INTRINSIC FEEDBACK FROM SYSTEM OPERATION

Moving Target Indicators
Target Location
Direction
Speed
Personnel or Vehicle

TES/IS PROVIDED INTRINSIC FEEDBACK

None

TRAINER PROVIDED INTRINSIC FEEDBACK

None

TES/IS INTRINSIC LIMITATIONS

None.

RSTA SYSTEM TRAINER CONTROL TASKS

DUTY POSITION	NONE
LOCATION	
TASK DESCRIPTION	Not required.

SYSTEM NAME AN/TPS-58B Moving Target Locating Radar (MTLR)

RSTA SYSTEM EXTRINSIC FEEDBACK REQUIREMENTS

TES/IS PROVIDED EXTRINSIC DATA

System:

Moving target indicators
Target location
Direction
Speed
Personnel or vehicle

TF FDC:

Targets

TRAINER PROVIDED EXTRINSIC DATA

System Data:

System search sector
Target location, direction, speed
Target = personnel or vehicle

Targeting Data passed:

Target location
Target type
Target direction
Target speed

UNATTAINABLE DATA

Player response to target acquisition

RSTA SYSTEM TRAINER DATA COLLECTION TASKS

DUTY POSITION	FS TF Analyst
LOCATION	TAF Facility
TASK DESCRIPTION	Plot actual system search sector. Record and report actual OPFOR activities within MTLR search sector. Record the following information from the FDC OC: Target location, type, direction, and speed.

DUTY POSITION	FA Bn FDC OC
LOCATION	Bn FDC
TASK DESCRIPTION	Monitor and record the following targeting data from the MTLR: Time target detected Target location Target type Target direction Target speed

To obtain the complete RSTA System Analysis database, please:

- o see the "New Products" section of the ARI Home Page (htp:/198.97.199.12) and select TAAF-Aids to download Appendix G

or

- o contact the U.S. Army Research Institute for the Behavioral and Social Sciences

APPENDIX H - C4I SYSTEMS ANALYSIS

C4I Systems Analysis

This appendix provides the findings of our Command, Control, Communications, Computers, and Intelligence (C4I) systems analysis. It also serves as an introduction for the following appendix that contains the C4I database reports. This appendix contains the following six sections:

(1) An introduction to our C4I analysis

(2) An introduction to the Army Battle Command System (ABCS), the Army Tactical Command and Control Systems (ATCCS) and the Tactical Internet (TI)

(3) Brief descriptions of each Army Tactical Command and Control (ATCCS) system and the Force XXI Battle Command Brigade and Below (FBCB2)

(4) Brief descriptions of the ATCCS support systems

(5) A walk through of the analysis we performed on the Maneuver Control System (MCS). (This section illustrates the methodology we used during our analysis of all the ATCCS systems.)

(6) The C4I systems analysis illustrations for the C4I systems analyzed

An Introduction to our C4I Analysis

We performed a full analysis on each of the Army Command and Control Systems (ATCCS) and the Force XXI Battle Command (FBCB2, formerly known as Appliqué). The ATCCS includes:

(1) The Maneuver Control System (MCS)

(2) The Advanced Field Artillery Tactical Data System (AFATDS)

(3) The Forward Area Air Defense System for Command and Control (FAADS C2)

(4) The All-Source Analysis System (ASAS)

(5) The Combat Service Support Control system (CSSCS)

We studied the ATCCS support systems to asses their impact on the ATCCS and the FBCB2 systems. The ATCCS support systems include:

(1) The Warfighter's Associate Terminal (WFA) which is part of the Global Broadcast System/Battlefield Awareness and Data Dissemination (GBS/BADD)

(2) The Integrated Meteorological system (IMETS) with Integrated Weather Effects Decision Aid (IWEDA)

(3) The Combat Terrain Information System (CTIS) with the Digital Topographic Support System (DTSS)

(4) The Air Mission Planning System (AMPS)

The goal of Army C4I systems is "Information Dominance." Current and near-term C4I systems will result in seamless connections horizontally and vertically across unit boundaries and echelons from the fox hole to the Pentagon.

The C4I systems at the Bn TF level focus on situational awareness (SA) and command and control (C2) information. However, the Bn Cdr and his staff will also have a multimedia capability to access information such as full motion video, 3D fly-bys over digitized terrain, and near-real-time Unmanned Aerial Vehicle (UAV) imagery. External decision support tools will also be accessible, such as detailed weather predictions and the impact of weather forecasts on planned operations, through the ATCCS support systems.

Cdrs will identify information critical to the success of the operation in a "Commander's Information Profile." The ATCCS use the profile to automatically route requested information to that commander. For example, a Cdr may request all recent information impacting on a specific geographical area (i.e., the Bn TF area of operations) and receive pertinent external decision support products such as, satellite fly-overs, and UAV imagery.

The challenge for exercise controllers is to provide player units all information the unit would receive and could reasonably access during combat operations. Controllers must provide the player unit connectivity to higher and adjacent C4I systems as well as the resources that those systems would contain. The challenge for OCs and TAF analysts is to isolate C4I information in an overwhelming data flow that has significant impact on the outcome of the battle.

An Introduction to the Army Battle Command System (ABCS), the Army Tactical Command and Control System (ATCCS), and the Tactical Internet (TI)

This section briefly describes the Army's current and future command and control architecture.

Army Battle Command System (ABCS)

The Army's overall communication architecture from the squad and platoon level to the strategic levels of the NCA (National Command Authority) is the Army Battle Command System (ABCS). The ABCS enables Cdrs and staffs to:

(1) Efficiently exchange, collect, and organize large amounts of information

(2) Synthesize information from multiple sources to create more complete and useful information

(3) Analyze trends

(4) Detect unusual activities

(5) Predict future situations

(6) Develop courses of action (DA, 1995)

The ABCS integrates information from the squad level to the strategic level. The system consists of three principle sub-architectures (DA, 1995):

(1) The Army Global Command and Control System (AGCCS) is the Army's strategic connection to the larger Global Command and Control System (GCCS).

(2) ATCCS is the primary system from corps to brigade levels, but Bn level TOCs have ATCCS and AGCC connectivity as well. The following is an extract from FM 24-7 Army Battle Command Systems (ABCS) Management Techniques addressing the ABCS doctrinal concept:

> The ABCS must be flexible to meet the full range of potential mission requirements... As an example, Cdrs at echelons as low as Bn may be in the role of a joint task force (JTF) Cdr in a humanitarian aid or peacekeeping mission in an underdeveloped country. <u>In this role, they (Bn Cdrs) need functionality and connectivity to systems as associated with the theater Cdr</u>. (DA, 1995).

(3) Force XXI Brigade Command Brigade and Below (FBCB2) systems are a family of computer platforms integrated into ATCCS at brigade and Bn levels designed to support situational awareness (SA) and command and control (C2) (DA, 1996). FBCB2 is also known as just BCB2 or "Appliqué."

Army Tactical Command and Control Systems (ATCCS)

The ATCCS connects the five Battlefield Functional Areas (BFAs), which are:

(1) Fire support (FS)

(2) Maneuver (MVR)

(3) Air defense (AD)

(4) Intelligence and electronic warfare (IEW)

(5) Combat service support (CSS)

The ATCCS provides SA, C2, and decision support tools for Cdrs and staffs, in the operational and tactical battle, at echelons corps and below (ECB). The ATCCS consists of the following systems:

(1) Maneuver Control System/Phoenix (MCS/P)

(2) Advanced Field Artillery Tactical Data System (AFATDS)

(3) Combat Service Support Control System (CSSCS)

(4) All Sources Analysis System (ASAS)

(5) Forward Area Air Defense System for Command and Control (FAADS C2)

Each of these systems has specialized functionality, but all share movement control, digital mapping, and terrain evaluation modules (DA, 1995).

Most of the ATCCS have embedded decision support tools. These tools automate many mundane tasks and present information to users in a way that assists in planning and decision making. For example, AFATDS analyzes incoming calls for fire, compares the target description to the Cdr's guidance/attack criteria, and recommends a fire support asset to attack the target. Depending on system parameters, AFATDS may also automatically process fire missions and transmit it to the appropriate weapon system.

ATCCS component system operators can access external decision support systems. For example, the MCS can interface with external decision support tools such as the Integrated Weather Effects Decision Aid (IWEDA). IWEDA provides detailed predictions on the effects of forecasted weather on friendly and enemy operations. IWEDA provides Cdrs and staffs with information on the best time to perform specific operations (Center of Army Digitization, 1996).

Tactical Internet (TI)

The Tactical Internet (TI) interfaces with the ABCS but primarily supports brigade and below communications. Individual soldier and weapon FBCB2 devices connect to the TI, and information may flow from the lowest levels throughout the ABCS network (DA, 1995).

The TI consists of the following primary communication systems:

(1) Enhanced Position Location Reporting System-Very High Speed Circuit (EPLRS-VHSIC)

(2) Single Channel Ground and Airborne Radio System, SINCGARS Improvement Program (SINCGARS SIP)

(3) Surrogate Digital Radio (SDR)

(4) Asynchronous Transfer Mode (ATM)

(5) Mobile Subscriber Equipment (MSE)

(6) Global Broadcast Service/Battlefield Awareness and Data Dissemination System (GBS/BADD) (DA, 1996)

EPLRS-VHSIC is a line-of-site radio system that transmits only data. EPLRS-VHSIC has the same basic capabilities as the standard EPLRS, except that designers have optimized it for the tactical internet. EPLRS-VHSIC provides host-to-host communications and a limited standalone free-text capability. These systems automatically send and receive most C2 and SA data. Many of these functions are completely transparent to the user (DA, 1996).

SINCGARS SIP provides enhancements for the standard SINCGARS. The improvements include a new receiver-transmitter, an amplifier-adapter, and integration of an Internet Controller (INC). The INC enables the SINCGARS to interface with other radios and digital devices (DA, 1996).

SDR provides the primary link between the Tactical Internet and the ABCS at brigade and Bn Tactical Operation Centers (TOCs). The SDR is the primary imagery and data communication transmission system at the brigade and Bn levels. The SDR provides limited range capabilities for "on-the-move" communications (DA, 1996).

ATM technology provides an efficient method for transmitting large amounts of data, voice, and video signals over a single communication link. ATM systems dynamically manage their bandwidth and can send the highest priority messages first. The ATM provides a multimedia and video teleconference (VTC) capability for field Cdrs (DA, 1996).

MSE is a circuit switched, digital communications system that provides data and voice communications at echelons corps and below. MSE is secure, flexible, and mobile. MSE provides links to adjacent corps, EAC, and commercial telephone lines (DA, 1996).

GBS/BADD satellite systems provide complete battlefield awareness. GBS/BADD consists of a satellite downlink site, the Information Dissemination Server (IDS) at the uplink site, the TI reachback link from Bn TOCs to the brigade, and the brigade's tactical satellite uplink. The GBS/BADD is capable of broadcasting large volumes of critical tactical information--video broadcasts, one way collaborative planning (higher to lower), UAV imagery, JSTARS data, and tactical situation data (DA, 1996b).

Cdrs at Bn and brigade TOCs have Warfighter's Associate (WFA) terminals. These terminals enable Cdrs to send their information profiles containing time, place, and type of information required. Bn TOCs send relatively small requests via the SDR to the Brigade TOC that, in turn, sends Bn requests via satellite reachback to the Information Dissemination Server (IDS). The IDS matches individual Cdr's requests against available data from historical archives, national repositories, and near-real-time sources (DA, 1996):

(1) Satellite images

(2) Three dimensional fly-bys

(3) JSTARS moving target indicators

(4) Live secondary imagery (SID)

(5) Common Ground Sensor (CGS) products

(6) Intelligence from Apache Longbow

(7) Video teleconferencing transmissions

(8) MCS SA and C2 graphics

(9) ASAS data

(10) Weather data

(11) Cable News Network (CNN) broadcasts

Brief Descriptions of Each Army Tactical Command and Control (ATCCS) System and the Force XXI Battle Command Brigade and Below (FBCB2)

This section provides an overview of the systems we analyzed for OC and TAF Analyst intrinsic and extrinsic tasks.

Maneuver Control System (MCS)

The MCS enables Cdrs to plan and execute operations using near-real-time battlefield information. MCS capabilities include:

(1) Providing all command posts (CPs) from Bn through corps with a common picture of the battlefield

(2) Providing information for quick assessment of enemy and friendly status

(3) Dissemination of orders, reports, and overlays (DA, 1995)

Our primary source of information on the capabilities of this system was "The Maneuver Control System Software User's Manual. (V12.01 Release 3, Build 3.0)." (PEOC3S, 1996). This also applies for the MCS analysis illustrations.

Advanced Field Artillery Tactical Data System (AFATDS)

The AFATDS' main function is to process fire missions and efficiently coordinate all FS assets including mortars, Field Artillery (FA), air support, and offensive electronic warfare (EW) (DA, 1995). The AFATDS uses distributed processing capabilities to select the most effective weapon system for target attack based on the Cdr's guidance, attack criteria, and priorities. AFATDS supports many fire support functions such as:

(1) Fire mission processing from corps through platoon fire direction centers

(2) In-battle updates for target analysis and unit status

(3) Coordination of target damage assessments and sensor operations

(4) Selection of the right mix of firing platforms and munitions to defeat enemy targets based on the Cdr's guidance, attack criteria, and priorities

(5) Control of fire support assets and allocation of fire support resources

(6) FS planning for future and current operations

(7) Logistical functions such as ammunition management (DA, 1995)

(8) Automatic fire mission processing

Our primary source of information on the capabilities of this system was the "Tactics, Techniques, and Procedures for the Advanced Field Artillery Tactical Data System (AFATDS)." (USAFAS, 1996). This also applies for the AFATDS analysis slides.

Combat Service Support Control System (CSSCS)

CSSCS manages all data required for logistics operations. It provides strategic and tactical Cdrs with timely and critical information on ammunition levels, fuel supplies, medical resources and supplies, personnel status, transportation, maintenance services, general supply, and other field services. CSSCS provides speed, flexibility, and integration for logistics tracking and transmits roll-up reports to other ATCCS computers (DA,1995).

Because the Army has not fielded the CSSCS below the brigade in task force elements, we only looked at the extrinsic requirements and tasks associated with CSSCS. These extrinsic requirements are important because CSSCS feeds other C4I systems. Players get the necessary logistics intrinsic feedback through the operation of their other ATCCS devices.

Our primary source of information on the capabilities of this system was the "Take a Tour of Combat Service Support System (CSSCS) Home Page." (Drown, 1997). This also applies for the CSSCS analysis slides.

All-Source Analysis System (ASAS)

ASAS is an intelligence support system that manages sensors and other intelligence resources. It collects, processes, and integrates intelligence data. ASAS stores, manipulates, displays and quickly disseminates enemy information to Cdrs across all battlefield functional areas. ASAS capabilities include:

(1) Transmission of a common intelligence picture to all ATCCS systems

(2) Provisions for Cdr's guidance to prioritize and manage collection assets

(3) Access to data from strategic and tactical sources to create ground-battle situation displays

(4) Support and recommendations for target development

(5) Simultaneous entry of sensor and other intelligence into a database that is accessible by multiple analyst workstations (DA, 1995)

Our primary sources of information on the capabilities of this system were the "Welcome to the Army's All Source Analysis System." (PM Intelligence Fusion, 1997) and "TRADOC PAM 525-XX." (TRADOC, 1996). This also applies for the ASAS analysis slides.

Forward Area Air Defense System for Command and Control (FAADSC2)

The FAADS C2 uses the Single Channel Ground and Airborne Radio System (SINCGARS) and the Army Data Distribution System (ADDS) for dissemination of ADA command information and ADA air battle management data. FAADS C2 capabilities include:

(1) Early warning

(2) Correlation of air tracks from multiple ADA units and transmission of those tracks to affected units

(3) Communication links with SINCGARS, Enhanced Position Location Reporting System (EPLRS), joint tactical information distribution system (JTIDS), and Mobile Subscriber Equipment (MSE) (DA, 1995)

Our primary sources of information on the capabilities of this system were the "FAAD GBS," (CECOM, 1997) and "FAADC3I GBS." (Director or Operational Testing and Evaluation, 1996). This also applies for the FAADS C2 analysis slides.

Force XXI Battle Command Brigade and Below (FBCB2) or Appliqué

FBCB2 systems are digital battle command information systems that combat, CS, and CSS units from brigade through platoon level use to enhance C2 and SA. Echelons below Bn level have only FBCB2 systems, but FBCB2 systems interface with all ABCS Battlefield Functional Area systems. FBCB2 enables individual soldiers, weapon platforms, sensors, and support platforms to generate, integrate, and process data both horizontally and vertically (DA, 1995). FBCB2 capabilities include:

(1) Providing current situational data for locations for friendly and enemy units

(2) Producing, storing, disseminating, and receiving messages, message acknowledgments, orders, requests, fires, reports, and alerts

(3) Producing, storing, disseminating, and receiving map overlays, intelligence data, obstacles, operational symbols, control measures, and battlefield geometry data

(4) Semi-automatically exchanging selected mission critical data between itself and the ABCS systems

(5) Ranking all messages by precedence, based on user-set filters

(6) Semi-automatic sharing of information between the ABCS and the Appliqué (DA, 1996b)

Figure H-1 depicts Appliqué interfaces and data flow with ATCCS (DA, 1996b).

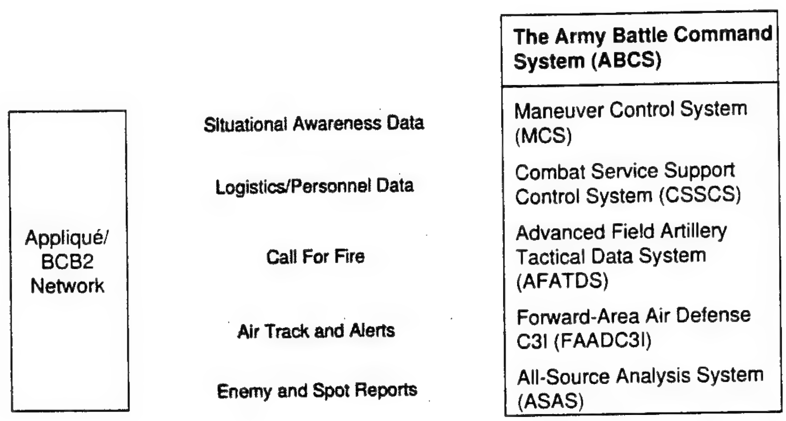


Figure H-1. Appliqué interfaces

Our primary sources of information on the capabilities of this system were the "Experimentation Master Plan for FBCB2," (ADO, 1995) and "The Warfighter's Digital Information Resource Guide (Task Force XXI)," (PEOC3S, 1996b). This also applies for the FAADS C2 analysis slides.

Brief Descriptions of the ATCCS Support Systems

The ATCCS support systems consist of the following systems:

(1) The Warfighter's Associate Terminal (WFA). It is part of the Global Broadcast System/Battlefield Awareness and Data Dissemination (GBS/BADD).

(2) The Integrated Meteorological System (IMETS).

(3) Combat Terrain Information System (CTIS) with The Digital Topographic Support System (DTSS).

(4) The Air Mission Planning System (AMPS).

The Warfighter's Associate. The WFA terminal sets both the battalion TOC and the brigade TOC. Battalion commanders can send their information requests from their WFA to the brigade WFA, where the brigade relays it to the Information Dissemination Server (IDS). The IDS receives National, Theater, and Tactical information. If information comes into the IDS that meets a commander's information request, IDS automatically sends that information to the commander's WFA terminal through the GBS/BADD system. This system may provide an almost unlimited ability to access information, even high-bandwidth information such as broadcast television, full-motion video, and detailed graphics.

The Integrated Meteorological System with the Integrated Weather Effects Decision Aid. IMETS with IWEDA provides weather effects forecasts. The system provides recommendations about the best/worst times to attempt different types of operations. IWEDA also provides commanders with recommendations about how the weather will affect the enemy. This enables commanders to use the weather as a force multiplier.

The Combat Terrain Information System with Digital Topographic Support System. CTIS with DTSS is a tactical system that provides automated terrain analysis and topographic products. These products include 3-D perspective views, and overlays based on specific requests. For example, a commander might want all the acceptable landing zones within an area of operation highlighted on the map.

The Air Mission Planning System. AMPS provides information on planned air routes, by mission number and aircraft type. AMPS gives air mission planners decision support tools based on least the visible routes, fuel allocations, loiter times, and other information.

A Walk Through of the Analysis We Performed on the Maneuver Control System (MCS)

This section illustrates the methodology we used during our analysis of all the C4I systems. We chose the Maneuver Control System (MCS) as our example system. It is one of the five Battlefield Functional Area (BFA) systems.

This section explores the Maneuver Control System (MCS), but we also list the assumptions we made that apply to our entire C4I systems analysis. We provide the MCS related intrinsic tasks, and extrinsic tasks. We also provide the current instrumentation system limitations that we identified when we looked at MCS. This MCS overview provides an example of how we addressed the entire C4I systems analysis. We placed all of the C4I analysis illustrations in the next section of this appendix.

MCS is the maneuver component of the ATCCS. It is the primary automated decision support/information system supporting the tactical commander and operational staff. See Figure H-2.

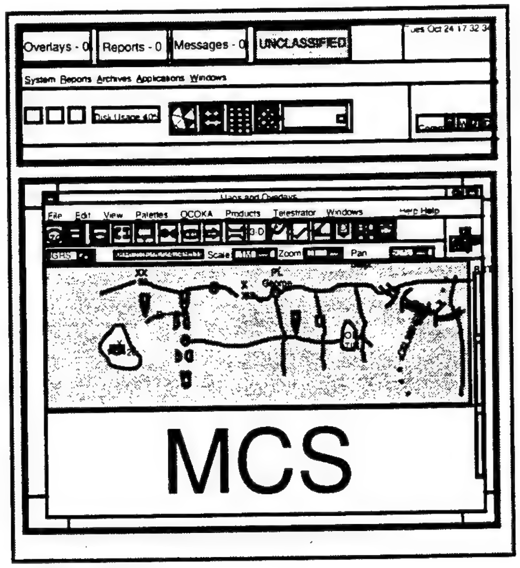


Figure H-2. The MCS map module display

<u>System Capabilities and Employment</u>

MCS provides a wide array of automated capabilities for planning and executing battles. MCS provides commanders and staff with the following functionality: (For a complete list see the MCS slides at the end of this appendix.)

- A common picture of the battlefield, including friendly and enemy locations, control measures, logistical, and personnel reports
- Digitized terrain data and maps
- Predictions on the situation, unit requirements, and unit capabilities
- Determinations about the impact of possible courses of action
- Tools for development of staff estimates
- Tools for finding and presenting conclusions (ADMP, 95)
- A client/server capability for the ATCCS and other C4I systems
- Interfaces with all ATCCS, many allied, joint, and other Army systems

- MCS provides reports for all classes of supply, Personnel, and Water
- A Map and Overlays Module (MOM) that displays common military symbology, and terrain analysis/visualization tools
- A messaging capability for the rapid exchange of C2 information
- A frame grabber that captures and transmits current screen shots
- An OPORD construction tool for automated organization and electronic distribution of the order
- A telestration capability for distributed "white-boarding"

Assumptions

The current instrumentation systems do not track player digital information. In order to identify the requirements and tasks pertaining to C4I systems, we made two assumptions. First, the Observer/Controllers (OCs) and Training Analysis Facility (TAF) Analysts must have digital systems that allow them to digitally role-play higher, adjacent, and supporting units. These systems must seamlessly inter-operate with player digital systems such as the ATCCS and FBCB2. Second, we assumed that the instrumentation system will capture all messages transmitted or received by players and mirror them on the digital workstation of the player's counterpart OC. Once in the OC's workstation, the associated TAF Analyst will have access to that information as well.

Intrinsic Feedback

If the players connect their C4I system to the appropriate communication networks and the C4I systems on those networks are operating properly, commanders and operators will get accurate and realistic intrinsic feedback. For example, if the brigade commander sends a digital overlay to battalion task force commander, the Bn TF Commander will either receive or not receive the message based on their communications connection, and the operation of the system, which is an accurate representation of what would happen during an actual deployment. In other words, it is an actual "Train-As-You-Fight" scenario. Figure H-3 illustrates the wide variety of standard interfaces that MCS can receive unassisted intrinsic feedback from during normal operation.

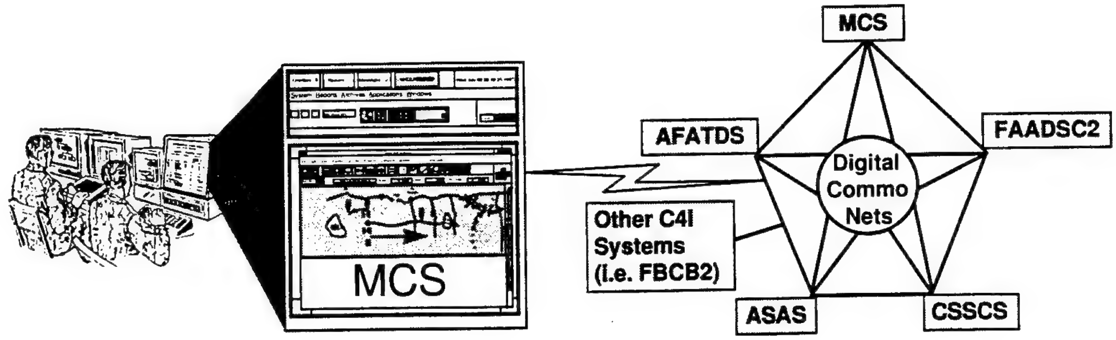


Figure H-3. MCS's ATCCS and FBCB2 interfaces

The intrinsic feedback portion that we do no address in the above scenario is the higher than brigade, adjacent unit, and supporting element's digital traffic to that Battalion Task Force Commander. Training center DTOC controllers must role play those other units and either provide the connections to supporting elements and assets or assist the player unit when they coordinate for support. See Figure H-4. Because of the intrinsic feedback capabilities inherent to C4I systems at the player lever, TAF Analysts do not have intrinsic tasks associated with them.

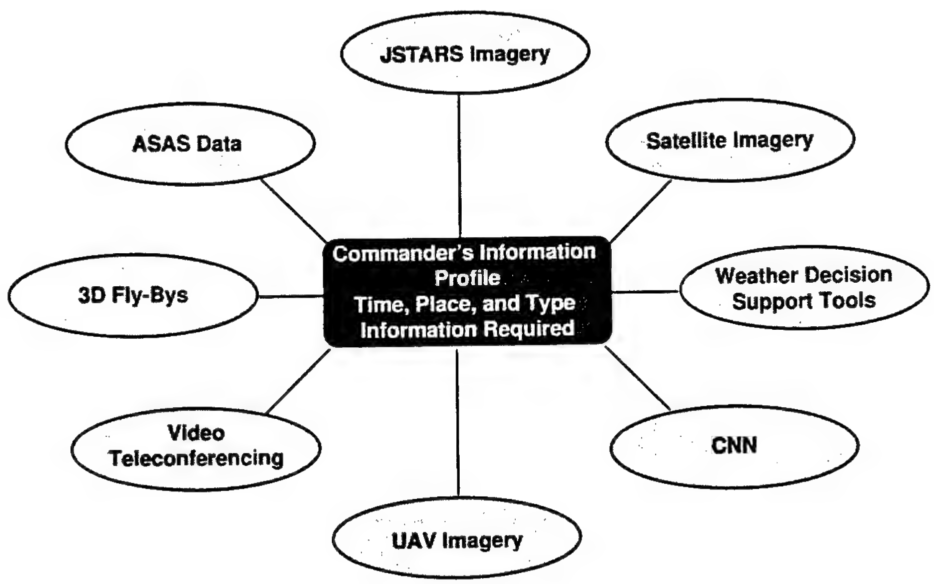


Figure H-4. Example information available to commanders

DTOC Controller and OC Tasks.

The DTOC controller and TF OC must role play higher, supporting and adjacent units. The DTOC controller will send and receive voice and digital warning orders, operations orders, overlays, FRAGOs, reports, warnings, free text messages, and requests. The DTOC controller will perform telestrations as division commander or higher. The DTOC controller will update unit task organizations as required. The

DTOC Controller will provide connections to notional player informational resources division and higher, as requested. For example, the player unit may request satellite images, a Cable News Network (CNN) feed, unmanned aerial vehicle (UAV) footage, or a 3D fly-by of their area of operation.

IS limitations

Currently, there is no instrumentation system (IS) associated with any player C4I systems. This means that OCs and Analysts can not inject control elements (intrinsic feedback) into the digital aspect of an exercise. Considering this limitation and the assumption that OCs will have a tactical digital system for control purposes it will not be possible for the input of notional player information into the Force Level Information (FLI) database especially at a resolution down to entity level.

Extrinsic Feedback

The players' extrinsic feedback will consist of four main things. First, as part of our assumptions, we determined that the instrumentation system will mirror all digital information sent to a player on the OC's digital workstation as well. This gives the OCs and TAF Analysts the ability to know what information the players had access to, and what the player perceived truth was. Second, the analysts need to use the current instrumentation system to access the "ground truth." Third, analyst must make a manual crosswalk between the perceived truth and ground truth and then pull the pertinent information into the AAR workstation for the creation of AAR products. Fourth, OCs must augment the data gathering process with on-site observations.

OC Tasks

The OC must observe staff appraisals and make assessments about the process used to develop and selection of courses of action. The OC must observe and record who attends briefbacks, the perceived understanding of the plan, and the production and dissemination of changes to the plan. The OC must observe and record the rehearsal type, the rehearsal process, and the participants understanding of the plan and changes to the plan.

TAF Analyst Tasks

The TAF Analyst must receive, record, and identify important items in higher, adjacent, and supporting OPORDs, overlays, FRAGOs, requests, reports, free text, messages, and warnings. The TAF Analyst records, and identifies important portions of all notional and actual telestration, and records player unit task organizations as required. In addition, the TAF Analyst must identify and record discrepancies between "ground truth" and "perceived truth," and their effects. The analyst will then take this information and build the appropriate AAR products.

IS limitations

Again, there is no instrumentation system (IS) associated with any player C4I systems. This means that OCs and Analysts can not pull AAR data directly from the information system (extrinsic data). This is why we formed our assumption that the instrumentation system will need to mirror all player data on the counter-part OC's work station. For AAR purposes, the TAF Analyst must pull that data from the OCs workstation, and make a manual crosswalk with the "ground-truth" systems for the construction of AAR products. Considering this limitation and the assumption that the OC and TAF Analyst have tactical systems there is no way to know what decision support tools the player used. For example, OCs and Analysts do not know what types terrain analysis tools they used. Analysts will know what information was available, but they will not know what information the players received, nor what they did with that information.

The C4I Systems Analysis Slides for All of the ATCCS Systems

The following pages in this appendix contain the complete analysis we performed on the ATCCS and FBCB2 C4I systems: AFATDS, ASAS, CSSCS, FAADS C2, FBCB2, and MCS. All of these systems are C4I representative systems or special cases because of the special functionality each ATCCS brings to its Battlefield Functional Area. For example, even though all the ATCCS computers share a common map module, the FAADS C2 is the only system that provides a "Slew-to-Cue" capability for the Avenger and Bradley Linebacker weapon systems.

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Intrinsic Feedback: Advanced Field Artillery Tactical Data System (AFATDS) #1

P - Common picture of enemy situation

P - Common picture of friendly situation specifically:
- Unit locations
- Fire Support Control Measures (FSCM)
- Target overlays
- All battlefield geometries
- Up to seven different overlays

P - Automatic screening of mission requests with recommendations for denying missions not meeting the commander's engagement criteria

P - Automated tools for battle damage assessment

P - Common operational symbols

P - Access and input into the Force Level Information (FLI) database

P - Reports and requests

P - Voice communications

P - Free text messages

P - Weather information

P - Automatic prioritizing of multiple missions based on mission value:
- Target type
- On-call precedence
- Priority of fires
- Targeted areas of interest

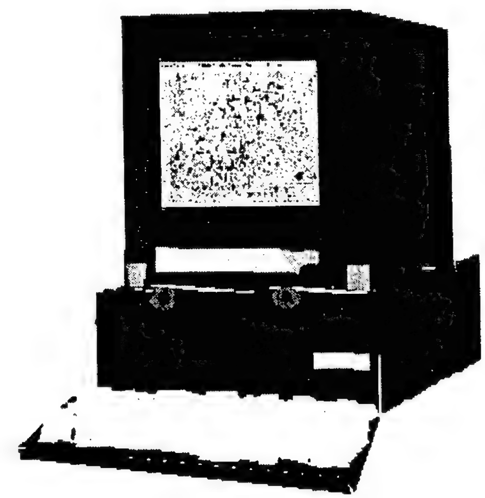
P - Automatic selection of fire support asset (e.g. FA, Mortars) depending on target type

P - Automatic selection of attack methodology based on FS asset and target (e.g. 1Bn volley, DPICM from 2-4 FA)

P - Automated high value/high priority targeting support in the Target Management Matrix (TMM)

P - Automated support for creation and modification of AFATDS database

AFATDS



N = No Feedback
I = Instrument Feedback
O = OC or TAF Analyst Feedback
P = Player Hands-On Feedback

Intrinsic Feedback: Advanced Field Artillery Tactical Data System (AFATDS) #2

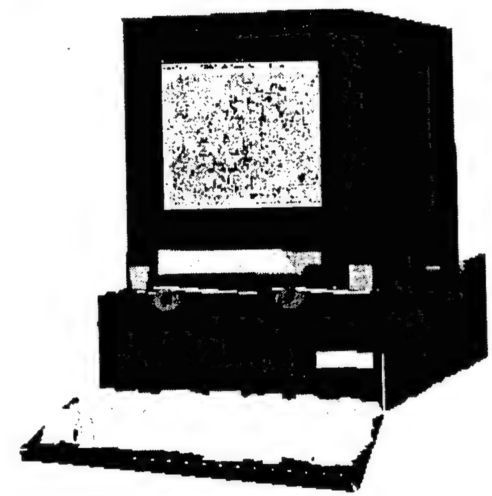
P - Common symbology
P - Automated course of action analysis (COA) based on:
  - Tubes in sector
  - Massing capabilities
  - Rounds required
  - Tasks supportable
  - System utilization

P - Automated field artillery estimate based on:
  - Total targets in COA
  - Acquirable targets
  - Attackable targets
  - Shell/Fuze quantities
  - Munitions/Effects calculator

P - Fire mission intervention points for rapid automatic mission processing (e.g. sensor to shooter) or human review and intervention, based on:
  - Target and mission types/values
  - Attack options
  - Target duplication
  - AFATDS denial recommendations

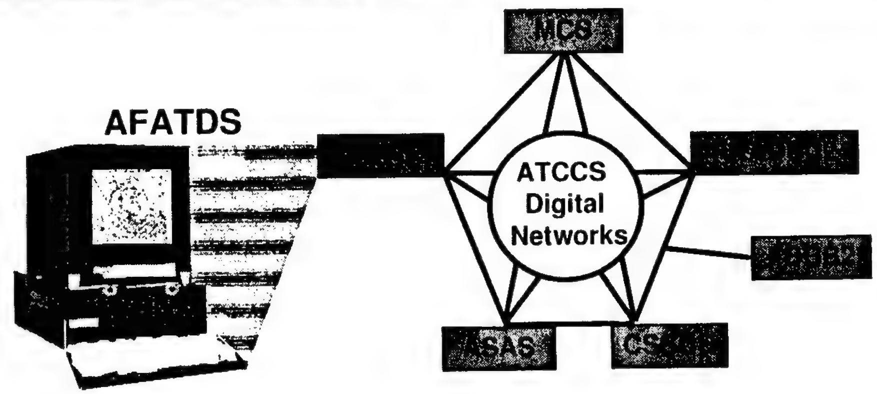
P - Automatic crosswalk between incoming missions and coordination measures and automatic coordination messages with conflicting units.
P - Automated creation and transmission of the fire support plan
P - Automated creation and transmission of the fire support execution matrix
P - Tracks and displays active and non-active missions
P - Tracks and displays logistics reports and status
P - Fire mission decision support through target filters:
  - Target selection standards
  - Target decay time
  - Target duplication
  - Target build-up areas
  - Target exclusion

AFATDS



N = No Feedback
I = Instrument Feedback
O = OC or TAF Analyst Feedback
P = Player Hands-On Feedback

Intrinsic Feedback: AFATDS Interfaces #1



AFATDS interfaces with the following Army Tactical Command and Control Systems (ATCCS):

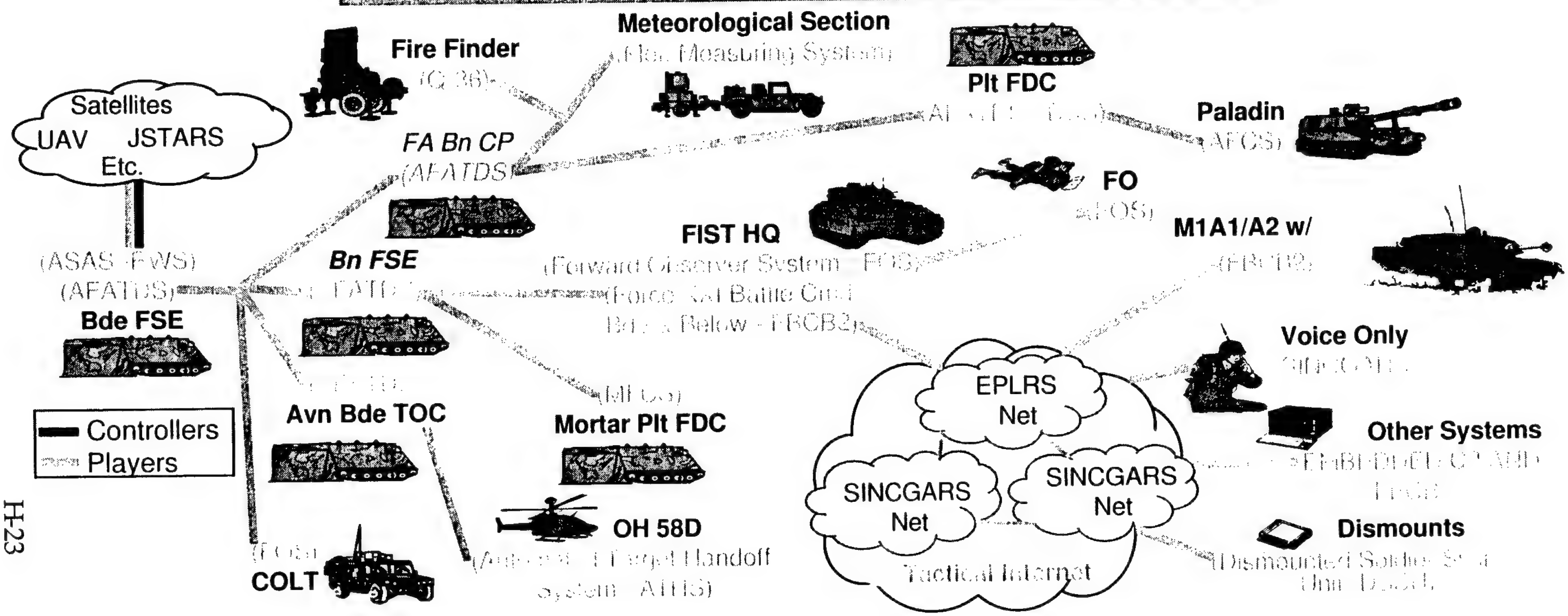
P - Other Advanced Field Artillery Tactical Data Systems (AFATDS)
P - Forward Area Air Defense System Command and Control (FAADSC2)
P - All Source Analysis Systems (ASAS)
P - Combat Service Support Control System (CSSCS)
P - Maneuver Control Systems (MCS)

N = No Feedback
I = Instrument Feedback
O = OC or TAF Analyst Feedback
P = Player Hands-On Feedback

Other Army systems that AFATDS interfaces with:

P - Force XXI Battle Command Brigade and Below
P - TACFIRE
P - Bde and Bn Forward Entry Device (FED), Light FED (LFED)
P - Fire Support Team (FIST) Digital Message Device (DMD)
P - Multiple Launch Rocket System (MLRS) and Army Tactical Missile System (ATACMS)
P - Meteorological Data System (MDS) and Meteorological Measuring System (MMS)
P - Fire Direction Data Manager (FDDM)
P - Automated Deep Operations Coordination System (ADOCS)
P - Firefinder Radar
P - Airborne Target Handover System (ATHS)
P - Battery Computer System (BCS)
P - Paladin Howitzer Automated Fire Control System
P - Mortar Ballistic Computer
P - Ground/Vehicular Laser Locator Designator (G/VLLD) with Fire Support Handheld Terminal Unit (FSHTU)

Intrinsic Feedback: AFATDS Interfaces #2



AFATDS interfaces with external systems:

P - Artillerie Daten Lage und Einsatz Rechnerverbund -- ADLER (German C2 system)

P - Battlefield Artillery Target Engagement System -- BATES (United Kingdom C2 system)

P - Joint Surveillance and Target Attack Radar system (JSTARS)

P - Guardrail

P - ATLAS (French C2 System)

P - Unmanned Aerial Vehicle (UAV)

AFATDS interfaces with other US services:

P - United States Marine Corps (USMC) AFATDS

P - USMC digital communications terminal

P - USMC intelligence systems

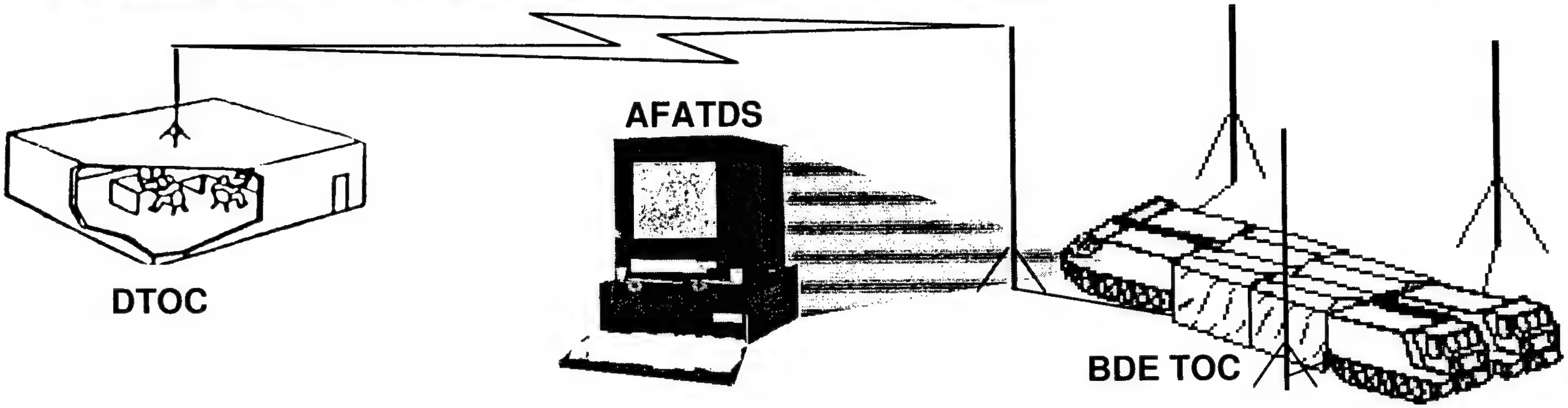
P - United States Air Force (USAF) C2 systems

P - Future plans for Shipboard AFATDS for US Naval Surface Fire Support (NSFS)

N = No Feedback
I = Instrument Feedback
O = OC or TAF Analyst Feedback
P = Player Hands-On Feedback

Illustration based on: The Warfighter's Digital Information Guide, December, 1996, PEOC3s and CECOM, Ft. Monmouth NJ

Intrinsic Feedback: AFATDS Higher, Adjacent, and Supporting Units



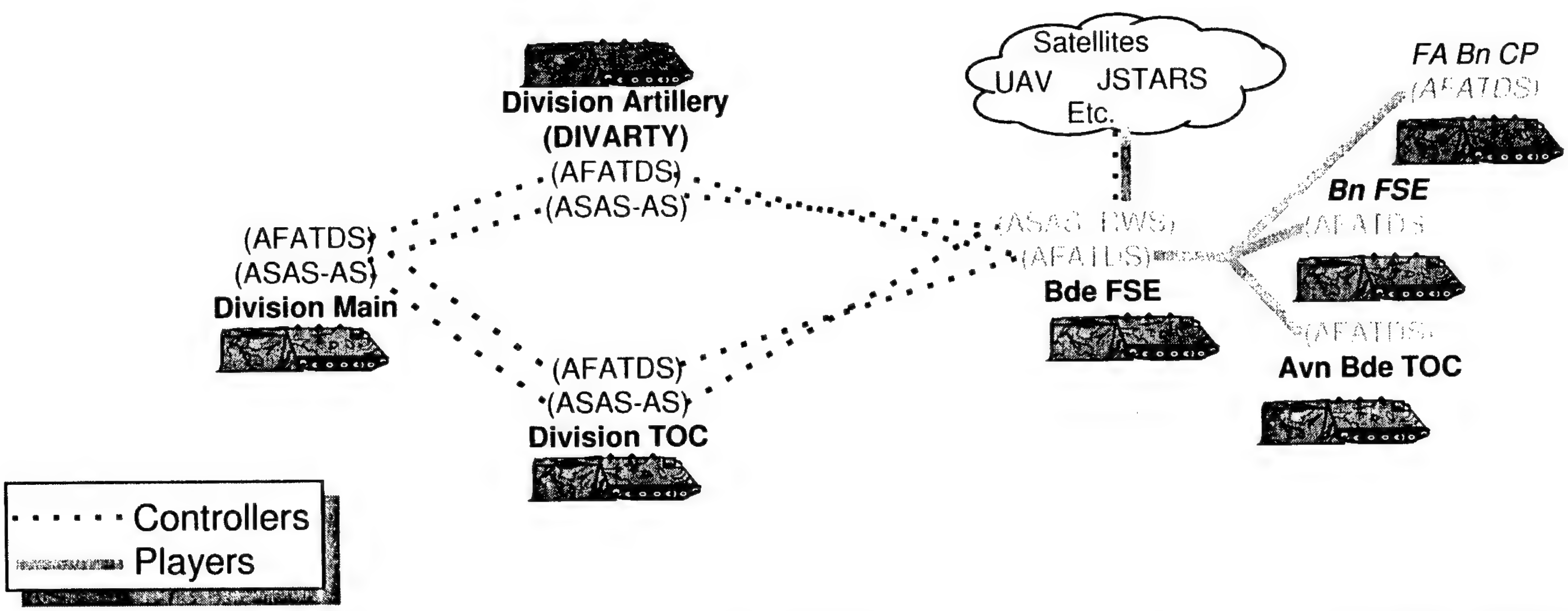
- O - Voice communications
- O - Digital communications
- O - Fire support overlays and graphics (DIVARTY)
- O - Requests
- O - Reports
- O - Free text messages
- O - Enemy situational data
- O - Target filtering, coordination, and designation (DMAIN)
- O - Clearance for fires across fire support coordination measures(DTOC)
- O - Controls MLRS (DIVARTY)
- O - Counterfire command element (DIVARTY)

- O - Review and refine mission priority guidance
- O - Fire planning for deep operations (DMAIN)
- O - Integration of fires into commander's scheme of maneuver
- O - Fire support plans (DIVARTY)
- O - Fire missions for GS and GSR units (DIVARTY)

- N - Notional player input to Force Level Information (FLI) database
- N - Notional player common picture (entity level resolution)

N = No Feedback
I = Instrument Feedback
O = OC or TAF Analyst Feedback
P = Player Hands-On Feedback

Intrinsic Feedback Tasks: AFATDS

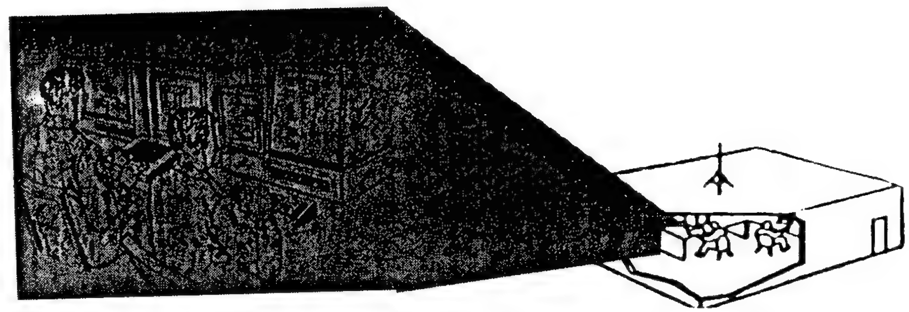


DTOC Controllers

1. Controller role plays higher, supporting and adjacent units.
2. Controller sends, receives, and actions:
   a. Voice and digital communications.
   b. Overlays/Graphics.
   c. Requests.
   d. Reports.
   e. Free Text Messages.
   f. Enemy situation updates.
3. Controller processes and provides:
   a. Targeting data.
   b. Enemy situational data.
   c. Commanding General's (CG) intent.
   d. Connections to other sensors, collection systems, and information.
   e. Field artillery guidance.
   f. Divisional field artillery support plan.
   g. Counterfire support.
   h. Deep attack operations and targets.
4. Controller translates CG's intent into AFATDS entries.
5. Controller manages and ensures flow of targeting, fire mission information, and Intelligence.
6. Controller coordinates clearance for fires across fire support coordination measures.

Extrinsic Feedback: AFATDS - Instrument Feedback

I - Voice communications
I - Ground truth entity dispositions



TAF "Ground Truth" Workstations and Radios

TAF

Note 1: "N" and "O"-coded items addressed on subsequent slides.
Note 2: AFATDS does not interface with the instrumentation system. However, the instrumentation system does provide the above data to support assessment of AFATDS employment.

N = No Feedback
I = Instrument Feedback
O = OC or TAF Analyst Feedback

Extrinsic Feedback: AFATDS OC & TAF Analyst Feedback

OC

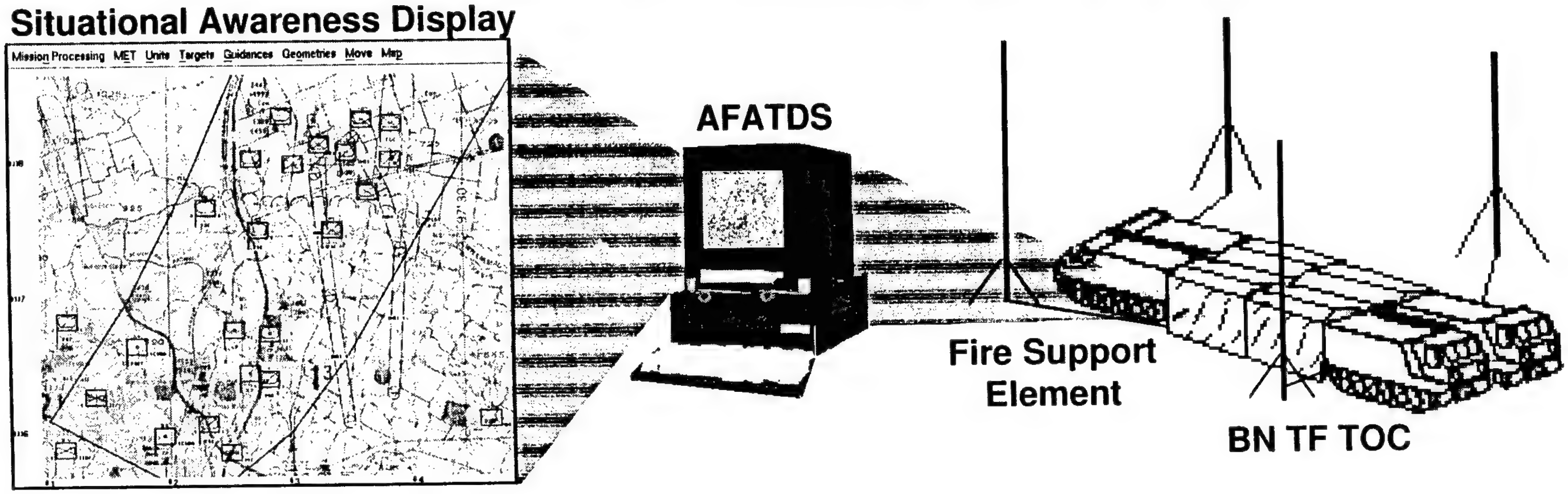
- O - Voice calls for fire
- O - Voice message to observers
- O - Staff procedures and interactions
- O - Translating commander's intent into AFATDS targeting guidance
- O - FDC and gun procedures

N = No Feedback
I = Instrument Feedback
O = OC or TAF Analyst Feedback

TAF Analyst

- O - Calls for fire
- O - Fire missions
- O - AFATDS estimates
- O - Information sources accessed
- O - Mission value criteria:
  - Target type
  - On-call precedence
  - Priority of fires
  - Targeted areas of interest
- O - Target filtering and screening guidance
- O - Digital communications: Fire Support plan, field artillery support plan, overlays/graphics, requests, reports, and free text messages
- O - Situational awareness
- O - Discrepancies between "ground truth" and "perceived truth," and their effects.
- O - Potential targets vs. attacked targets
- O - Results of attacks (Battle Damage Assessments)

Extrinsic Feedback: AFATDS No Feedback



N - Decision support tools used:
- Views of the terrain and situation (level of detail and overlay viewed)
- AFATDS recommendations and when intervention points were used or overridden

N - Player actions and inactions on received information and reports

N - AFATDS system not integrated with current instrumentation system for collection of digital data

N = No Feedback
I = Instrument Feedback
O = OC or TAF Analyst Feedback

Extrinsic Feedback TAF Analyst Tasks: AFATDS

TAF Analyst

1. Analyst crosswalks the fire support and field artillery support plans with the execution of fires.
2. Analyst transfers required digital information from the AFATDS into the instrumented workstation, to include:
   a. Digital communications.
   b. Fire missions.
   c. Calls for fire.
   d. Situational awareness.
   e. Overlays/Graphics.
   f. Reports.
   g. Free text messages.
   h. Requests.
   i. Commander's intent, guidance, and information requirements.
   j. Targets fired.
   k. Attack assessments.
   l. AFATDS estimates.
   m. Results of attacks (Battle Damage Assessments - BDA).
3. Analyst records player access to external information sources.
4. Analyst crosswalks the mission value criteria with the targets attacked and the results (BDA).
5. Analyst records potential targets vs. attacked targets.
6. Analyst identifies discrepancies between "ground truth" and "perceived truth," and their effects.

Extrinsic Feedback OC Tasks: AFATDS

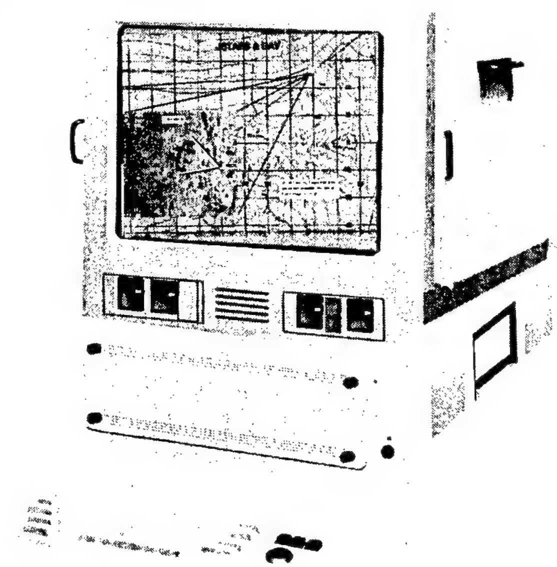
OC

1. OC observes and assesses course of action development, selection, and the fire planning process.
2. OC observes fire mission processing.
3. OC observes staff procedures and information accessed.
4. OC informs TAF analyst of all observations.
5. OC crosswalks commander's intent into AFATDS targeting guidance.
6. OC informs TAF analyst of voice calls for fire.
7. OC informs TAF analyst of message to observer (MTO).
8. OC informs TAF analyst when mission fired and any FDC or gun errors.

Intrinsic Feedback: All Source Analysis System (ASAS)*#1

- P - Common picture of enemy situation:
  - What
  - Where
  - When
  - Speed
  - Direction
- P - Battlespace visualization:
  - Near battle
  - Deep battle
  - Target nomination
- P - Automated event alarms
- P - "Relevant" common picture dictated by operators
- P - Automated tools for analysis and synthesis
- P - Battle damage assessment
- P - Operational symbols
- P - Access and input into the Force Level Information (FLI) database
- P - Terrain evaluation module
- P - Common symbology
- P - Overlay and templating tools
- P - Requests
- P - Voice communications
- P - Reports with automatic roll-up capability
- P - Free text messages
- P - Weather information
- P - Keyword searches
- P - Control of focused targetable intelligence system
- P - Timely, valid, and accurate targeting assistance

The ASAS-Remote Workstation (RWS)



N = No Feedback
I = Instrumented Feedback
O = OC or TAF Analyst Feedback
P = Player Hands-On Feedback

For the results of the analysis for additional C4I systems, please:

- o see the "New Products" section of the ARI Home Page(htp:/198.97.199.12) and select TAAF-Aids to download Appendix H

or

- o contact the U.S. Army Research Institute for the Behavioral and Social Sciences

APPENDIX I - C4I SYSTEMS DATABASE REPORTS

C4I SYSTEM DATABASE INFORMATION

Appendix I is a report printed from the C4I section of the TAAF Aids database. It includes the data from all of the C4I systems that we have analyzed.

All of the information about each system appears together in the report. Each C4I system has three main sections:

(1) The System Title Pages. This section contains the name of the system, a brief description of the system, and lists the named system's interfaces with other C4I systems.

(2) The Intrinsic Information Pages. This section contains both the intrinsic feedback requirements and the OC and TAF Analyst control tasks for that system.

(3) The Extrinsic Information Pages. This section contains both the extrinsic feedback requirements and the OC and TAF Analyst data collection tasks.

Each C4I system has at least three pages associated with it. If a section's information does not fit completely on one page, the report will add an additional page for that section. In most cases, additional pages will contain trainer tasks. All trainer tasks are easily identifiable by their gray backgrounds. Regardless of the total number of pages per system, the organization is always the same (System Title Pages, Intrinsic Information Pages, and Extrinsic Information Pages). See Figure I-1 for an illustration of the groupings and the information contained with each C4I system.

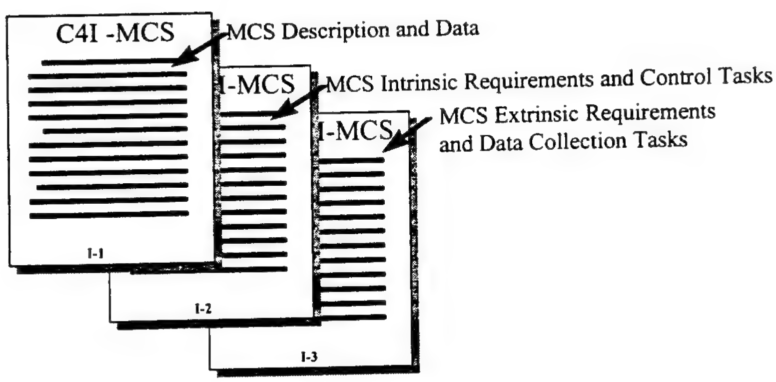


Figure I-1. Organization of Appendix I

C4I SYSTEMS

SYSTEM NAME Advanced Field Artillery Tactical Data System (AFATDS)

NOMENCLATURE AFATDS

DESCRIPTION

AFATDS is the fire support component of the Army Tactical Command and Control System (ATCCS). It is a digital system that integrates all aspects of the fire support battlefield functional area (BFA) into one computer system. AFATDS will be employed from the firing platoon through the corps. It provides fire support decision assistance to commanders and operators. AFATDS also provides tactical firing solutions and integrated communications with firing units and platforms. AFATDS takes advantage of graphical capabilities, decisions aids, and embedded training. It will provide the Army and the Marine Corps automated tools for fire support command, control, and communications. AFATDS also links the fire support BFA to the other ATCCS.

BOS/ART Firepower

TES/IS USED None

SYSTEM INTERFACES

AFATDS interfaces with the following Army Tactical Command and Control Systems (ATCCS):

- Other Advanced Field Artillery Tactical Data Systems (AFATDS)
- Forward Area Air Defense System Command and Control (FAADSC2)
- All Source Analysis Systems (ASAS)
- Combat Service Support Control System (CSSCS)
- Maneuver Control System (MCS)

Army systems that AFATDS interfaces with:

- Force XXI Battle Command Brigade and Below (FBCB2)
- TACFIRE
- Bde and Bn Forward Entry Device (FED), Light FED (LFED)
- Fire Support Team (FIST) Digital Message Device (DMD)
- Multiple Launch Rocket System (MLRS) and Army Tactical Missile System (ATACMS)
- Meteorological Data System (MDS) and Meteorological Measuring System (MMS)
- Fire Direction Data Manager (FDDM)
- Automated Deep Operations Coordination System (ADOCS)
- Firefinder Radar
- Airborne Target Handover System (ATHS)
- Battery Computer System (BCS)
- Paladin Howitzer Automated Fire Control System
- Mortar Ballistic Computer
- Ground/Vehicular Laser Locator Designator (G/VLLD) with Fire Support Handheld Terminal Unit (FSHTU)

AFATDS interfaces with external systems:

- Artillerie Daten Lage und Einsatz Rechnerverbund -- ADLER (German C2 system)
- Battlefield Artillery Target Engagement System -- BATES (United Kingdom C2 system)
- Joint Surveillance and Target Attack Radar system (JSTARS)
- Guardrail
- ATLAS (French C2 System)
- Unmanned Aerial Vehicle (UAV)

AFATDS interfaces with other US services:

- United States Marine Corps (USMC) AFATDS
- USMC digital communications terminal
- USMC intelligence systems
- United States Air Force (USAF) C2 systems
- Future plans for Shipboard AFATDS for US Naval Surface Fire Support (NSFS)

SYSTEM NAME Advanced Field Artillery Tactical Data System (AFATDS)

C4I SYSTEM INTRINSIC FEEDBACK REQUIREMENTS

INTRINSIC FEEDBACK FROM SYSTEM OPERATION

Common picture of enemy situation
Common picture of friendly situation specifically, the unit locations, Fire Support Control Measures (FSCM), target overlays, all battlefield geometries, and up to seven different overlays.
Automatic screening of mission requests with recommendations for denying missions not meeting the commander's engagement criteria.
Automated tools for battle damage assessment
Common operational symbols
Access and input into the Force Level Information (FLI) database
Reports and requests
Voice communications
Free text messages
Weather information
Automatic prioritizing of multiple missions based on mission value based on the target type, on-call precedence, priority of fires, and targeted areas of interest.
Automatic selection of fire support asset (e.g. FA, Mortars) depending on target type
Automatic selection of attack methodology based on FS asset and target (e.g. 1Bn volley, DPICM from 2-4 FA).
Automated high value/high priority targeting support in the Target Management Matrix (TMM)
Automated support for creation and modification of AFATDS database
Common symbology
Automated course of action analysis (COA) based on the number of tubes in sector, the current massing capabilities, the number of rounds required, the tasks that are supportable, and current system utilization.
Automated field artillery estimate based on the total targets in a COA, the acquirable targets, the attackable targets, the available shell/fuse combinations, and calculations from the Munitions/Effects calculator.
Fire mission "Intervention Points" for rapid automatic mission processing (e.g. sensor to shooter) or for human review and intervention, based on the target and mission types/values, the attack options, any target duplication, and AFATDS denial recommendations.
Automatic crosswalk between incoming missions, existing coordination measures, and automatic coordination messages to conflicting units.
Automated creation and transmission of the fire support plan and execution matrix.
Tracks and displays active and non-active missions
Tracks and displays logistics reports and statuses
Fire mission decision support through target filters such as, target selection standards, target decay time, target duplication, target build-up areas, and target exclusion.

TES/IS PROVIDED INTRINSIC FEEDBACK

None.

TRAINER PROVIDED INTRINSIC FEEDBACK

Voice communications
Digital communications
Fire support overlays and graphics (DIVARTY)
Requests
Reports
Free text messages
Enemy situational data
Target filtering, coordination, and designation (DMAIN)
Clearance for fires across •fire support coordination measures(DTOC)
Controls MLRS (DIVARTY)
Counterfire command •element (DIVARTY)
Review and refine mission priority guidance
Fire planning for deep operations (DMAIN)
Integration of fires into commander's scheme of maneuver
Fire support plans (DIVARTY)
Fire missions for GS and GSR units (DIVARTY)

TES/IS INTRINSIC LIMITATIONS

Notional player input to Force Level Information (FLI) database
Notional player common picture (entity level resolution)

C4I SYSTEM CONTROL TASKS

SYSTEM NAME **Advanced Field Artillery Tactical Data System (AFATDS)**

DUTY POSITION	DTOC Controller
LOCATION	DTOC
TASK DESCRIPTION	Role plays higher, supporting and adjacent units. Sends, receives, and actions: Voice and digital communications. Overlays/Graphics. Requests. Reports. Free Text Messages. Enemy situation updates. Processes and provides: Targeting data. Enemy situational data. Commanding General's (CG) intent. Connections to other sensors, collection systems, and information. Field artillery guidance. Divisional field artillery support plan. Counterfire support. Deep attack operations and targets. Translates CG's intent into AFATDS entries. Manages and ensures flow of targeting, fire mission information, and Intelligence. Coordinates clearance for fires across fire support coordination measures.

SYSTEM NAME Advanced Field Artillery Tactical Data System (AFATDS)

C4I SYSTEM EXTRINSIC FEEDBACK REQUIREMENTS

TES/IS PROVIDED EXTRINSIC DATA

While AFATDS is not integrated or connected to the instrumentation system, the current instrumentation system already provides voice communications and "ground-truth" disposition. These two data elements can be used to assess fire support operations and employment of AFATDS.

TRAINER PROVIDED EXTRINSIC DATA

Voice calls for fire
Voice message to observers
Staff procedures and interactions
Translating commander's intent into AFATDS targeting guidance
FDC and gun procedures
Calls for fire
Fire missions
AFATDS estimates
Information sources accessed
Mission value criteria:
- Target type
- On-call precedence
- Priority of fires
- Targeted areas of interest
- Target filtering and screening guidance

Digital communications:
- Fire Support plan
- Field artillery support plan
- Overlays/graphics
- Requests
- Reports
- Free text messages

Situational awareness
Discrepancies between "ground truth" and "perceived truth," and their effects
Potential targets vs. attacked targets
Results of attacks (Battle Damage Assessments)

UNATTAINABLE DATA

Decision support tools used:
- Views of the terrain and situation (level of detail and overlay viewed)
- AFATDS recommendations and when intervention points were used or overridden

Player actions and inactions on received information and reports.
AFATDS is not integrated with current instrumentation system for collection of digital data.

C4I SYSTEM DATA COLLECTION TASKS

DUTY POSITION	**TAF Analyst**
LOCATION	**TAF**
TASK DESCRIPTION	**Analyst crosswalks the fire support and field artillery support plans with the execution of fires. Analyst transfers required digital information from the AFATDS into the instrumented workstation: Digital communications Fire missions Calls for fire Situational awareness Overlays/Graphics Reports Free text messages Requests Commander's intent, guidance, and information requirements Targets fired Attack assessments AFATDS estimates**

Results of attacks (Battle Damage Assessments - BDA)
Analyst records player access to external information sources.
Analyst crosswalks the mission value criteria with the targets attacked and the results (BDA).
Analyst records potential targets vs. attacked targets.
Analyst identifies discrepancies between "ground truth" and "perceived truth," and their effects.

DUTY POSITION	Fire Support OC
LOCATION	Player Location
TASK DESCRIPTION	OC observes and assesses course of action development, selection, and the fire planning process. OC observes fire mission processing. OC observes staff procedures and information accessed. OC informs TAF analyst of all observations. OC crosswalks commander's intent into AFATDS targeting guidance. OC informs TAF analyst of voice calls for fire. OC informs TAF analyst of message to observer (MTO). OC informs TAF analyst when mission fired and any FDC or gun errors.

To obtain the complete C4I System Analysis database, please:

- o see the "New Products" section of the ARI Home Page(htp:/198.97.199.12) and select TAAF-Aids to download Appendix I

or

- o contact the U.S. Army Research Institute for the Behavioral and Social Sciences

APPENDIX J - AAR PREPARATION TASKS ANALYSIS

AAR Preparation Tasks

This appendix provides the findings of our AAR Aid preparation analysis. In the paragraphs that follow we describe the methodology we employed to determine the impact of force modernization on OC and TAF analyst workload during AAR preparations. This appendix contains the following sections:

(1) An introduction to our AAR Preparation Tasks analysis

(2) An introduction to the methodology we used during this analysis

(3) An introduction to the AAR Aid Preparation slides

(4) The AAR Aid Preparation slides

An Introduction to Our AAR Preparation Tasks Analysis

AARs focus on the unit's performance as part of each battlefield operating system (BOS). To capitalize on this, we identified a representative task from each BOS. Next, we looked at the data collection and aid construction tasks involved in the preparation of AAR aids.

NOTE: Army Tactical Systems (ARTs) is the new term for BOS. During the course of the study, however, we found that even recent documentation rarely used the new term. We use the term BOS since most readers are familiar with the older term.

An Introduction to the Methodology We Used During This Analysis

We selected our representative tasks from each BOS using the Center for Army Lessons Learned (CALL) quarterly Maneuver CTC trends publication. We focused on tasks assessed by CALL as "needs emphasis" tasks.

After we identified a representative task for each BOS, we performed the analysis shown in Figure J-1.

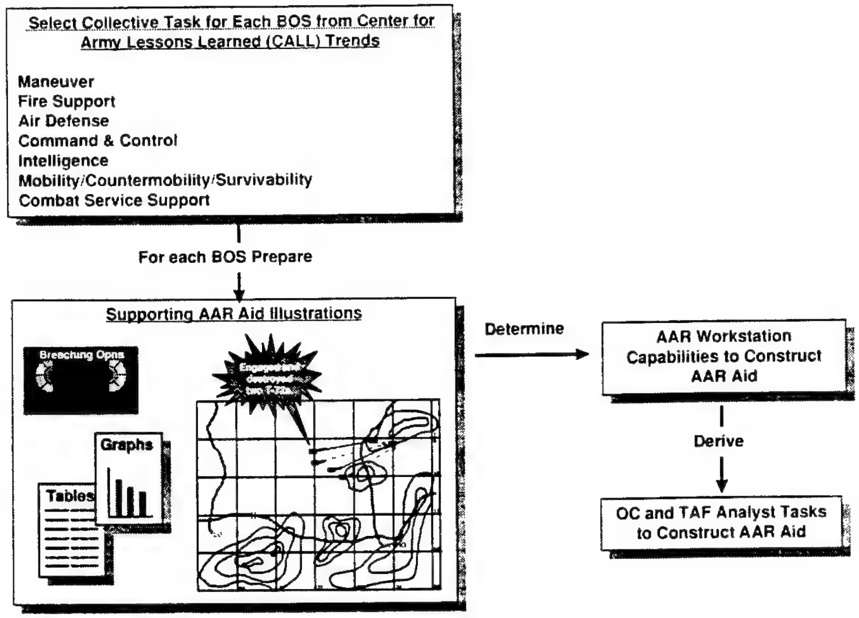


Figure J-1. Identify AAR aids for representative BOS tasks

We assigned each AAR aid a title, then we identified the AAR aid type. The following is a list of the aid types we used in this study:

(1) The Word Slide Aid. This aid contains text. For example, an aid that lists the MTP or TTP standards and procedures for a given task or text describing how to improve.

(2) The Plan View Aid. This aid shows real video of the given task or mission.

(3) The Graph Aid. This aid depicts statistical information about a given task or mission, in graph form.

(4) The "A Way" Aid. This aid shows either a textbook solution to the task or a historical aid that shows a successful execution of the same or similar task or mission. It is an alternative method.

(5) The Snapshot Aid. This aid is a frame grab from the top-down display of the ground-truth instrumentation system.

(6) The Table Aid. This aid depicts statistical information about a given task or mission, in table form.

(7) The Video Aid. This aid shows actual video footage of the given task or mission. It usually contains audio segments as well.

(8) The Firefight Aid. This aid shows the rounds exchanged between the OPFOR and BLUFOR.

(9) The Timeline Aid. This aid shows statistical information about a given task or mission, in timeline form.

In addition to the above-listed nine aid types, we also identified seven more types of aids that we did not illustrate during this analysis. They are:

(1) The Stealth View Animation. This aid shows an "out-the-window" type of view from inside a virtual vehicle.

(2) Stealth View Stills. This aid is similar to the Stealth View Animation, except that it is "freeze-framed" instead of full-motion.

(3) The Battleflow Aid. This aid is an overlay type of aid that places "snail-trails" behind each vehicle or player so controllers can see the route each player took.

(4) The Voice Communications Aid. This aid re-plays recorded voice transmissions. Controllers can use it as a stand-alone aid or they can connect it to video and other aids.

(5) The Digital Communication Aid. This aid shows digital transmissions in display or message formats.

(6) The Digital Camera Aid. This aid uses digital cameras to quickly capture "stills" from the exercise and insert them into the AAR.

(7) The Computer-Generated Forces (CGF) Aid. This aid uses CGF to show AAR participants "text-book" solutions to their exercise problems, or Controllers can use CGF aids to enable AAR participants to run "what if" types of scenarios.

An Introduction to the AAR Aid Preparation Illustrations

Our analyses of the BOS-based AAR Aid preparation tasks appear in the illustrations at the end of this appendix. There are three main sections for each set of illustrations. They are: Identification of the player unit's tactical weakness, the AAR Aids used to show the learning points, and the OC/TAF Analyst data collection and aid construction tasks for those aids.

Assumptions

We assumed that future instrumentation systems will track the location of all impacting rounds, even the misses. We also assumed that AAR workstations will enable analysts to create many different types of AAR aids. For example, the analyst may assemble video segments and audio, snapshots, animations, graphs and tables, etc.

<u>The AAR Aid Preparation Illustrations</u>

In this section of the appendix, we present our analysis of AAR Aid preparation. We grouped the analysis illustrations by BOS. Each BOS has the following AAR Aids associated with it:

(1) The Intelligence BOS has eight aids: two Word Slide Aids, four snapshot Aids, and two "A Way" Aids.

(2) The Combat Service Support BOS has five AAR Aids: two Word Slide Aids, one Snapshot Aid, two Table Aids.

(3) The Mobility/Counter-Mobility/Survivability BOS has nine AAR Aids: two Word Slide Aids, two Plan View Aids, one Graph Aid, one Video Aid, one "A Way" Aid, one Snapshot Aid, and one Table Aid.

(4) The Fire Support BOS has six AAR Aids: two Word Slide Aids, one Plan View Aid, two Snapshot Aids, and an "A Way" Aid.

(5) The Maneuver BOS has nine AAR Aids: two Word Slide Aids, two Snapshot Aids, two Graph Aids, two Firefight Aids, and one Video Aid.

(6) The Air Defense Artillery BOS has four AAR Aids: two Word Slide Aids, one Snapshot Aid, one, and one "A Way" Aid.

(7) The Command and Control BOS has three AAR Aids: two Word Slide Aids and one Timeline Aid.

AAR Aids: Air Defense Artillery BOS The Subjective Evaluation

The ADA's use of their organic sensors was not adequate. Specifically, the positioning and orientation was ineffective. I think some Snapshot Aids and an "A Way" Aid might show this point.

OC

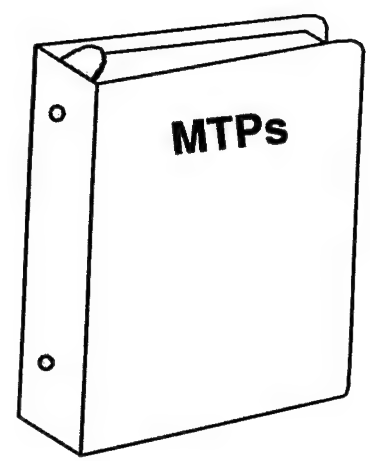
Roger, I'll link that to the MTP and make the AAR Aids based on your observations.

ADA TAF Analyst

Linking of Subjective Evaluation to Military Standards and Procedures

OK, I've got my ADA MTP. Its ARTEP 44-115-MTP. Now let's see, sensor placement and orientation... Right, here it is. That's task number 44-4-2369. Let me copy those standards down onto a Word Slide Aid. I'll only use the specific tasks that are needed to make the learning point.

ADA TAF Analyst



Aid 1: Task Standards

TASK: Provide early warning (ARTEP 44-115-MTP, Task 44-4-2369)

TASK STEPS and PERFORMANCE MEASURES

2. The staff develops an early warning plan. The plan:

   d. Concentrates early warning resources as per IPB, ADA priorities, and designated NAIs.

   e. Enhances ground-based sensor and/or ADA scout survivability during movements to contact and hasty attacks.

3. The staff ensures the early warning plan contains:

   a. Redundancy of coverage.

   b. Resources to maintain ground-based sensor and ADA scout coverage according to the IPB requirements.

   c. Resources for attaching ground-based sensors and ADA scouts under operational control of ADA liaison officers in maneuver TOCs, if required by task organization.

   f. Survivability plans for early warning assets include frequent movement, engineer support for ground-based sensor and ADA scout survivability positions, and placing communications support high on the priority list.

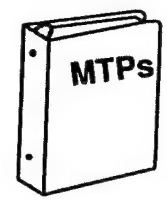
Aid 1: Collection and Construction Tasks

The ADA's use of their organic sensors was not adequate. Specifically, the positioning and orientation was ineffective. I think some Snapshot Aids and an "A Way" Aid might show this point.

OC

1. Identify specific areas of unit tactical weakness.
2. Inform TAF analyst.
3. Provide guidance to TAF analyst for specific areas of interest for AAR.

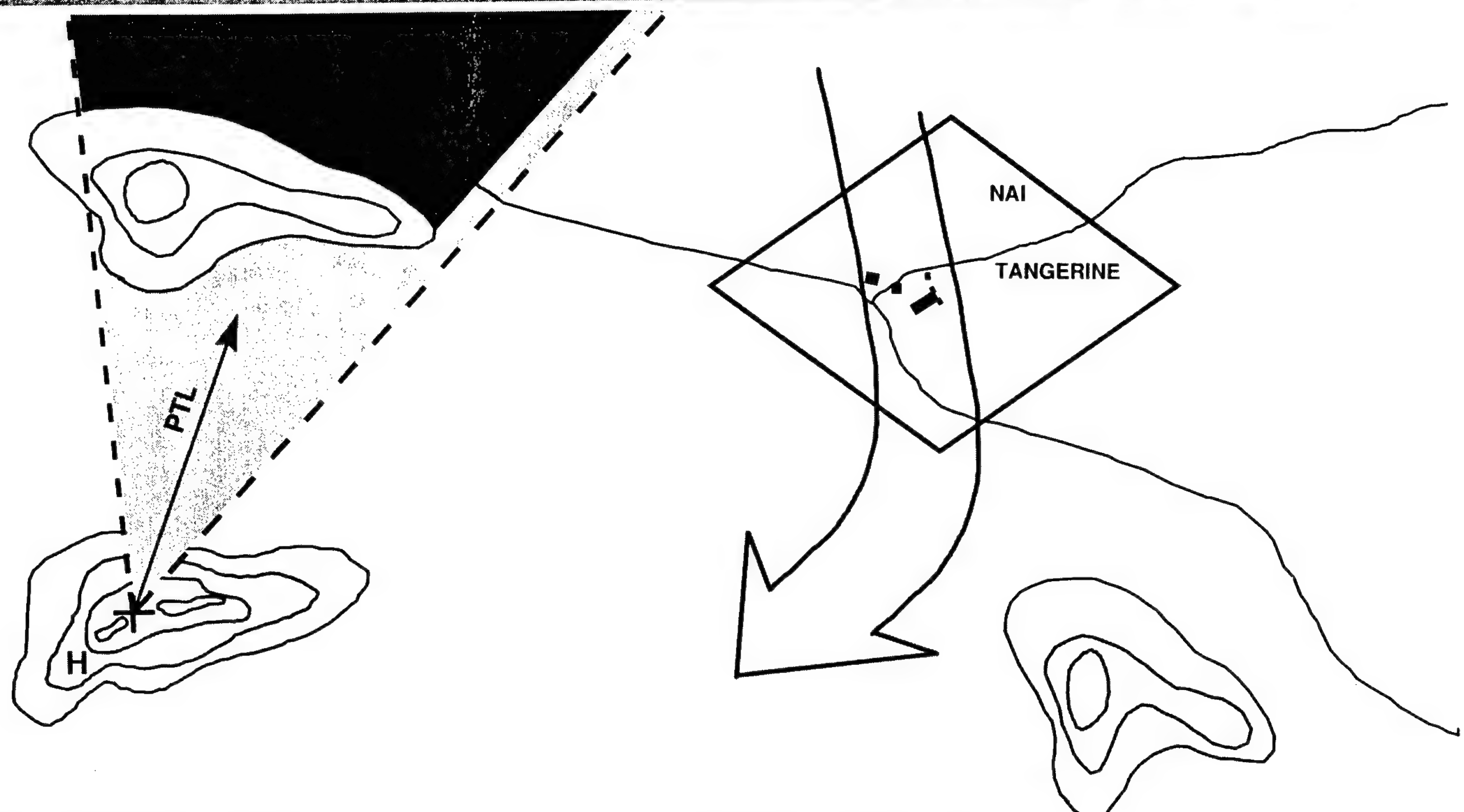
Roger, I'll link that to the MTP and make the AAR Aids based on your observations.



AVN/ADA TAF Analyst

1. Record specific areas of unit tactical weakness.
2. Record guidance from OC on specific areas of interest for AAR.
3. Obtain appropriate MTP No. 44-115-MTP (paper or electronic copy).
4. Identify tasks related to OC's evaluations.
5. Enter standards, procedures, and references from appropriate MTP tasks into AAR aid.
6. Enter aid title.

Aid 2: Sensor Section Deployment



H - HMMWV Location

+ - Sensor location

- Observable line of sight

PTL - Primary Target Line

- Enemy Air Avenue of approach

- Unobserved area

How did you determine the primary enemy air avenue of approach into your sector?

How did you use NAIs in your planning?

Aid 2: Collection and Construction Tasks

AVN/ADA TAF Analyst

1. Enter aid title.
2. Pan to geographic area of operation.
3. Obtain OPORD and scan in operations overlay.
4. Scan in ADA operations overlay.
5. Prepare Snap Shot AAR aid of each section's occupation and emplacement.
6. Develop open-ended questions to support the aid.

OC

1. Transport copy of OPORD and ADA operations overlay to AVN/ADA TAF analyst.

Aid 3: How to Improve

1. Key Leaders must ensure that sensors are not positioned to far to the rear of the brigade sector, to maximize detection range of system.
2. Position Radar/sensor systems along suspected enemy air avenues of approach.
3. Sensor section leaders must ensure radar is properly oriented to have line of sight for all NAIs, and positioned according to S2 priorities and expected enemy actions.
4. Train perishable skills at home station, particularly data link-up operations with the Simplified hand-held terminal unit (SHTU).
5. Train and discuss local air defense warnings (LADWs) at Home Station training, so section will be able to disseminate radar detections quickly and properly.
6. Train units reaction to LADWs at Home Station. SOP's should address reaction drills for air attack in tactical assembly areas, offensive, and defensive operations.

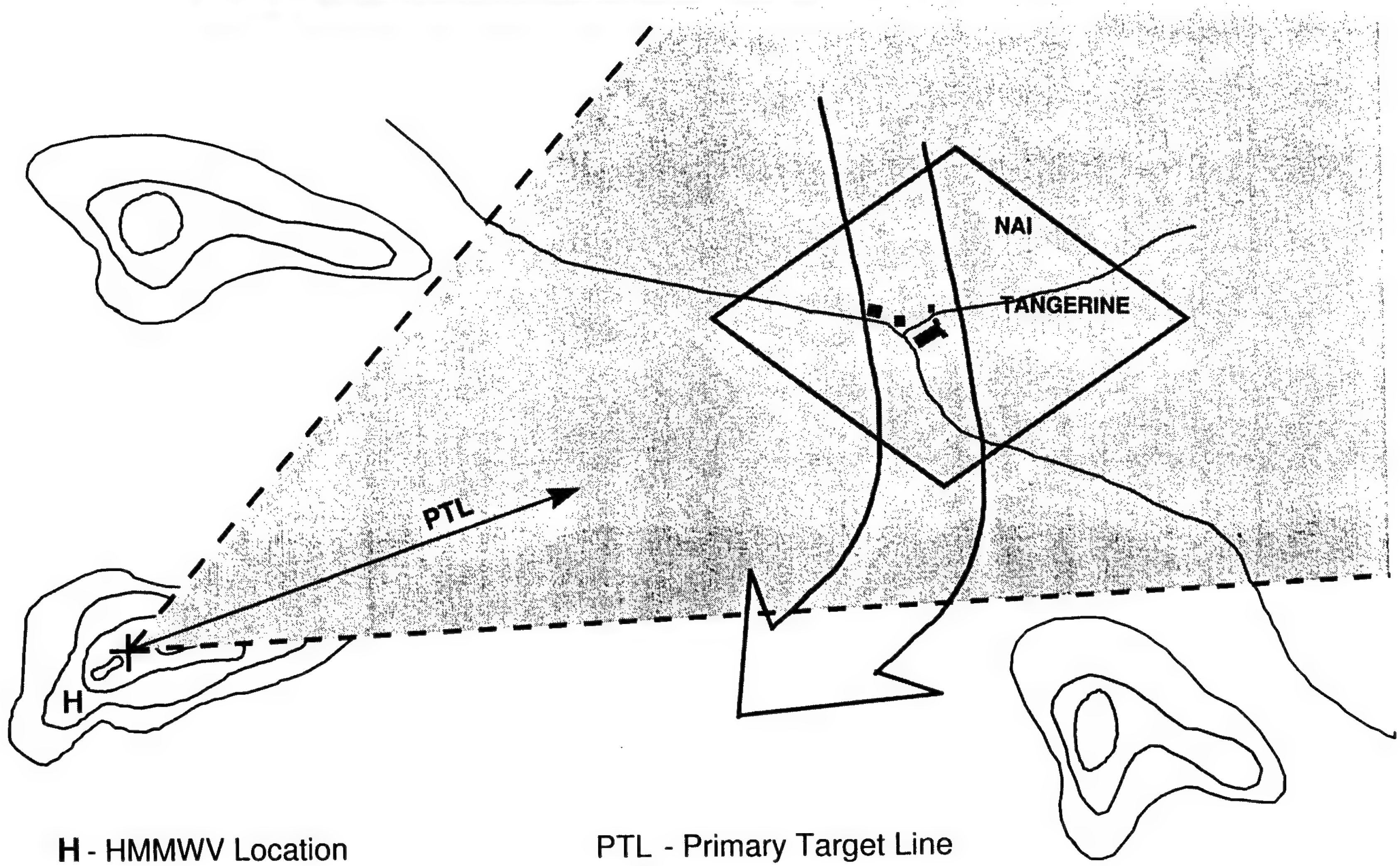
NOTE: Information above provided by CALL Trends Tactics, Techniques, and Practices.

Aid 3: Collection and Construction Tasks

AVN/ADA TAF Analyst

1. Enter aid title.
2. Review, enter and reference applicable TTP and Center for Army Lessons Learned (CALL) Trends and Solutions.
3. Consult ARTEP 44-115-MTP, FM 44-48, and enter any applicable comments.

Aid 4: How to Improve



H - HMMWV Location

+ - Sensor location

- Observable area

PTL - Primary Target Line

- Enemy Air Avenue of approach

Aid 4: Collection and Construction Tasks

AVN/ADA TAF Analyst

1. Enter aid title.
2. Pan to geographic area of the operation.
3. Show a successful positioning and orientation from a previous rotation ("A Way").
4. In lieu of 3 above, create Snap Shot AAR aid providing the correct ADA coverage as an alternative solution.

To obtain examples of automated After Action Review (AAR) aid production for other BOS, please:

- o see the "New Products" section of the ARI Home Page (htp:/198.97.199.12) and select TAAF-Aids to download Appendix J

or

- o contact the U.S. Army Research Institute for the Behavioral and Social Sciences

APPENDIX K -- CROSSWALK OF STRATEGIES TO OC AND TAF ANALYST TASKS

This appendix crosswalks strategies in the basic report with all OC and TAF control and feedback tasks identified in the study. We reviewed all analysis results, eliminating task duplication. There were occasions when an OC and TAF analyst performed different aspects of the same task. When this occurred, we counted the task once for the OC and once for the TAF analyst. Our analysis of intrinsic and extrinsic feedback requirements for force modernization initiatives, AAR and THP preparations, and OC mentoring identified 380 distinct control and feedback tasks.

The spreadsheet contained in this appendix shows the impact of the study's 13 strategies in reducing OC and TAF analyst workload using the following legend:

F--Tasks fully eliminated by a strategy or combination of strategies

M--Tasks in which a strategy or combination of strategies eliminates a majority of the requirements

P--Tasks in which a strategy or combination of strategies eliminates some aspects of the requirements.

The spreadsheet is sub-divided into categories--weapons, RSTA, C4I, AAR, OC mentoring, and THP.

Appendix K -- Crosswalk of Strategies to OC and TAF Analyst Tasks

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
				WEAPONS												
1	Abrams, AH64 Hellfire, Avenger, Multispectral Obscurant	OC	Assess battle damage for rules of engagement (ROE) violations.	P			P	M	M				P			
2	Abrams, AH64 Hellfire, Avenger, Multispectral Obscurant	OC	Assess battle damage for inoperative MILES or AGES/AD					F	F				F			
3	Abrams, AH64 Hellfire, Avenger, Multispectral Obscurant	OC	Assess battle damage for MILES limitations: "MILES berms," "Leaf defilade," "Canvas defilade"					F	F							
4	Abrams, AH64 Hellfire, Avenger, Multispectral Obscurant	OC	Record battle damage for rules of engagement (ROE) violations.	P			P	M	M				P		P	
5	Abrams, AH64 Hellfire, Avenger, Multispectral Obscurant	OC	Record battle damage for inoperative MILES.					F	F				M		P	

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
6	Abrams, AH64 Hellfire, Avenger, Multispectral Obscurant	OC	Record battle damage for MILES limitations: "MILES berms," "Leaf defilade," "Canvas defilade."					F	F						P	
7	Abrams, Avenger, Multispectral Obscurant	TAF Analyst	Record manual and instrumented battle damage assessments from OC					F	F				P			M
8	AH64 Hellfire	TAF Analyst	Record manual and instrumented battle damage assessments from OC		P			F	F				P			M
9	Abrams, AH64 Hellfire, Avenger, Multispectral Obscurant	OC	Record type combat damage for MILES or AGES/AD engagements					F	F						P	
10	AH64 Hellfire	OC	Record type combat damage for MILES or AGES/AD engagements		P			F	F						P	
11	Abrams, AH64 Hellfire, Avenger, Bean Bag Round, LWS, Multispectral Obscurant, Electric Water Cannon	OC	Record shooter and victim ID for control gun assessments					F	F						P	

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
12	Abrams, AH64 Hellfire, Avenger, Multispectral Obscurant, LWS, Bean Bag Round, Aqueous Foam Barrier, Electric Water Cannon,	OC	Inform TAF analyst of results					M	M						M	
13	AH64 Hellfire	OC	Determine if aircraft survivability equipment (ASE) is on or off.					F	F						P	
14	AH64 Hellfire	OC	Inform TAF analyst on status of ASE					F	F						M	
15	Avenger	OC	If counter measures used, manually assess battle damage.					F	F							
16	Avenger	OC	Assess victim battle damage based on engagement					F	F							
17	M56	OC	Determine positioning, start time, duration, delivery means, and type smoke employed.									F			M	
18	M56	OC	Evaluate obscurant effects on player and OPFOR.											M	P	
19	M56	OC	Forward information to MVR TAF analyst												M	
20	M56	MVR TAF Analyst	Record smoke information from OC											P		M
21	M56	MVR TAF Analyst	Obtain wind direction and speed											F		F
22	M56	MVR TAF Analyst	Plot obscurant position information on top down display.									M		M		M

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
23	Multispectral Obscurant	OC	Record player ID, obscurant type, and time employed.									F			M	
24	Multispectral Obscurant	TAF Analyst	Coordinate with OPFOR to determine type ordnance fired and inform OC													P
25	Multispectral Obscurant	OC	Record ordnance information from MVR TAF analyst												M	
26	Multispectral Obscurant	OC	Determine effectiveness of the multispectral obscuration based on the obscurant type used and ordnance fired by the shooter to determine the target's ability to avoid direct hits from the shooting vehicle and assess BDA as required					F	F					P	P	
27	Crusader	Firing Plt OC	Evaluate gun section procedures and inform FDC OC.	M			M	M	M			P			P	
28	Crusader	FDC OC	Evaluate and record call for fire, observer ID, and FDC procedures	P			P	P	P		P				P	
29	Crusader	FDC OC	Monitor and record call for fire and FDC procedures	M			M	M	M		P				P	
30	Crusader, PGMM	FDC OC	Record shooter ID, shooter location, target location, and information from Firing Plt OC on gun/mortar section procedures	M	P		M	M	M		P	M			M	
31	Crusader	OC	Record ammunition type and amount on hand	M	P		M	M	M		P	F			P	
32	Crusader	OC	Record ammunition type fired and amount	M	P		M	M	M		P	F			P	
33	Crusader	FDC OC	If gun procedures valid, send fire mission to FS TAF analyst.	F			F	F	F			F			M	
34	Crusader	TAF Analyst	Enter fire mission into SAWE control station.	F	P		F	F	F			F				F

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
35	Crusader	TAF Analyst	If fires fall on dismounted soldiers, locate the nearest fire marker and send him to mark location of impacting ordnance.				F	F	F							P
36	Crusader	TAF Analyst	If fires do not fall on player vehicles, or are smoke or illumination missions, locate the nearest fire marker and send him to mark location of impacting ordnance.				M	M	F							P
37	Crusader, PGMM, EFOG-M, Longbow Hellfire	Firemarker	Record location, volume, and type ordnance to mark from TAF analyst.	P			M	M	F							
38	Crusader	Firemarker	Mark impacting ordnance with air, ground burst, smoke grenades, or illumination flares as directed	P			M	M	F							
39	PGMM	OC	Evaluate and record observer procedures, call for fire, and FDC procedures	P	P		P	P	P		P				P	
40	PGMM	OC	Evaluate mortar section procedures; inform FDC OC of results	M			M	M	M						P	
41	PGMM	OC	Record information from Mortar Plt OC on mortar section procedures	M			M	M	M						M	
42	PGMM	OC	If mortar section and FDC procedures are valid, send fire mission to TAF analyst	F			F	F	F		P				P	
43	PGMM	TAF Analyst	Record information received from mortar Plt FDC OC and mortar Plt FDC OC				P	P	P							M
44	PGMM	TAF Analyst	Plot weapon footprint, locate vehicles within footprint if present		F				F							M

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
45	PGMM	TAF Analyst	Assess battle damage according to PK, if PK results in kill administratively kill vehicle from TAF facility		F				F							M
46	PGMM	AVN Analyst	Plot target location.		F			F	F							M
47	Longbow Hellfire	AVN OC	Coordinate and monitor shooter procedures to engage target.					F	F		P				P	
48	Longbow Hellfire	AVN OC	Record target description and location					F	F		P				P	
49	Longbow Hellfire	AVN OC	If procedures valid, forward shooter and target information to AVN analyst.					F	F						M	
50	Longbow Hellfire	AVN Analyst	Record shooter ID and target location from AVN OC.					F	F							M
51	Longbow Hellfire	AVN Analyst	Plot target location.					F	F							M
52	Longbow Hellfire	AVN Analyst	Plot missile(s) footprint					F	F							M
53	Longbow Hellfire	AVN Analyst	If entities within footprint, assess battle damage according to PK					F	F							M
54	Longbow Hellfire	AVN Analyst	Administratively kill entities from TAF facility					F	F							M
55	Longbow Hellfire	AVN Analyst	Inform OPFOR that AH-64D Longbow Hellfire killed the vehicle					F	F							M
56	EFOG-M	Plt OC	Record shooter ID and location, planned flight route, ammunition on hand and amount fired, and time missile launched.					F	F		P	P			M	
57	EFOG-M	Plt OC	Provide FS TAF analyst the launcher ID, planned flight route, ammunition on hand, and time missile launched.					F	F		P	P			M	

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
58	EFOG-M	S2 OC	Record observer ID, target description, and location received from UAV.								M				P	
59	EFOG-M	Plt OC	Forward information to FS TAF analyst												M	
60	EFOG-M	FS TAF Analyst	Identify shooter on top down display.													M
61	EFOG-M	FS TAF Analyst	Plot target location received from S2 OC.								M					M
62	EFOG-M	FS TAF Analyst	Plot planned flight route.													P
63	EFOG-M	FS TAF Analyst	Plot loiter radius of weapon based on range to target and cable consumed to determine weapon search footprint					F	F							P
64	EFOG-M	FS TAF Analyst	If vehicle is located at mission target location, assess battle damage based on maximum PK.					F	F							P
65	EFOG-M	FS TAF Analyst	If no vehicle located at mission target location but within weapon search footprint, assess battle damage at lower PK.					F	F							P
66	EFOG-M	FS TAF Analyst	If calculation of PK results in kill, administratively kill vehicle from TAF facility.					F	F							M
67	EFOG-M	TAF Analyst	Record victim ID, location, and battle damage assessment					F	F		P					M
68	EFOG-M, PGMM	TAF Analyst	If PK does not result in kill, locate nearest firemarker and send him to mark location of impacting ordnance					F	F							P
69	EFOG-M, PGMM	Firemarker	Mark impacting ordnance as directed					F	F							
70	Volcano Mine System	ENGR OC	Evaluate procedures used to emplace minefield.									F				

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
71	Volcano Mine System	ENGR OC	Record minefield location, size, density, orientation, destruct time, and type and inform TAF analyst								M	F			P	
72	Volcano Mine System	ENGR TAF Analyst	Record minefield information received from ENGR OC.								M	F				M
73	Volcano Mine System	ENGR TAF Analyst	Plot minefield affected area into top-down display IAW ENGR OC instructions								M	F				M
74	Volcano Mine System	ENGR TAF Analyst	Enter minefield affected area into SAWE control station for casualty and battle damage assessment.								M	F				M
75	Volcano Mine System	ENGR TAF Analyst	Record casualty and battle damage assessment from minefield	F			F	F	F			P		F		M
76	Volcano Mine System	ENGR OC	Record and assess effectiveness of minefield location, size, density, orientation, destruct time, and type and inform analyst												P	
77	ORSMC	ENGR TAF Analyst	Coordinate with OPFOR TAF LNO on smart mine locations, annotate mine locations on top down view and inform ENGR OC and firemarker of mine locations									F				M
78	ORSMC	ENGR TAF Analyst	Plot mine locations, density, orientation, and type								P	F				M
79	ORSMC	ENGR OC	Record location of smart mines received from ENGR analyst.	F			F	F	F			F			P	

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
80	ORSMC	ENGR OC	Notify ENGR analyst when unit dispatches off road smart mine clearance vehicle and provide planned route.									F			M	
81	ORSMC	ENGR OC	Record and inform TAF analyst of off road smart mine clearance vehicle start time, start location, and planned route												P	
82	ORSMC	ENGR TAF Analyst	Record actual vehicle route used with range of radiating signals visible on top-down view									F		P		M
83	ORSMC	ENGR TAF Analyst	Direct firemarker(s) to vicinity of OPFOR smart mine locations.				F	F	F							
84	ORSMC	Firemarker	Record smart mine locations from ENGR analyst.				F	F	F			F				
85	ORSMC	Firemarker	Mark smart mine detonation when directed by ENGR analyst				F	F	F							
86	ORSMC	ENGR OC	If remote vehicle runs over dumb mine, kill remote vehicle with control gun and inform TAF analyst					F	F						P	
87	ORSMC	ENGR TAF Analyst	Turn off SAWE and monitor remote vehicle movement with range of radiating signals visible on top down view, as remote vehicle approaches smart mines, direct firemarkers to mark mine detonation				F	F	F							M
88	ORSMC	ENGR TAF Analyst	If another player vehicle(s) enters area containing the smart mine and/or dumb mine while SAWE is off, administratively kill vehicle(s) IAW PK calculations.					F	F							P

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
89	ORSMC	ENGR TAF Analyst	Upon conclusion of route clearance, mark cleared lane in SAWE mine field based upon path cleared by remote vehicle and re-activate the SAWE minefield.					F	F			F				M
90	ORSMC	ENGR OC	Record battle damage assessment from control gun kills from dumb mine detonations					F	F						P	
91	ORSMC	ENGR TAF Analyst	Record battle damage assessments for other player vehicle administrative kills and OC control gun assessments					F	F							P
92	Intelligent Minefield	ENGR OC	Provide ENGR analyst control vehicle ID.												M	
93	Intelligent Minefield	ENGR OC	Monitor emplacement of minefield; determine if set for manual or remote arming and notify analyst.									F			P	
94	Intelligent Minefield	ENGR OC	Record minefield location, size, orientation, time emplaced, and density and inform TAF analyst								P	F			P	
95	Intelligent Minefield	ENGR OC	Monitor and record minefield for manual and remote arming of mines									F			P	
96	Intelligent Minefield	ENGR OC	When mines remotely armed, notify analyst.									F			M	
97	Intelligent Minefield	ENGR TAF Analyst	Identify control vehicle ID on top down display and record minefield information from ENGR OC.								P	F				M
98	Intelligent Minefield	ENGR TAF Analyst	Plot minefield affected area into SAWE control station and arm mines IAW ENGR OC instructions.									F				

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
99	Intelligent Minefield	ENGR TAF Analyst	Inform ENGR OC of vehicles approaching mines.								M				M	M
100	Intelligent Minefield	ENGR OC	Inform remote control station operator of vehicles approaching mines.						F							
101	Intelligent Minefield	ENGR OC	Inform analyst of location of mines to be command detonated.									F			M	
102	Intelligent Minefield	ENGR OC	If unit command detonates mines, record time detonated and location of mines and inform TAF analyst									F			P	
103	Intelligent Minefield	ENGR TAF Analyst	For non-command detonated minefield or minefield belts enter into the SAWE control station, for SAWE casualty and battle damage assessment.	F			F	F	F					P		M
104	Intelligent Minefield	ENGR TAF Analyst	For command detonated minefield or minefield belts, assess casualties and battle damage through administrative kills in accordance with PK if remote station within range.	M			M	M	M			P				M
105	Intelligent Minefield	ENGR TAF Analyst	Record casualties and battle damage from command detonated mines	M			M	M	M			P				M
106	Intelligent Minefield	Firemarker	Mark mine detonations as directed				F	F	F							
107	BIDS, MICAD	NBC TAF Analyst	Record NBC mission attack data from OPFOR					P	P							M
108	BIDS, MICAD	NBC TAF Analyst	Inform NBC OC of attack location, type agent and affected area.				P	P	P							M
109	BIDS, MICAD	NBC OC	Record attack location and agent type from TAF analyst				P	P	P						M	

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
110	BIDS, MICAD	NBC OC	Introduce indication of NBC agents to the system.													
111	MICAD	NBC OC	Mark location of chemical attack with exploding ordnance				M	M	F							
112	BIDS, MICAD	NBC TAF Analyst	Plot affected area in SAWE control station.													M
113	BIDS	NBC OC	Evaluate BIDS section procedures, report results to NBC analyst.									P			M	
114	MICAD	NBC OC	Evaluate MICAD procedures; report results to ENGR/NBC TAF analyst									P			M	
115	BIDS, MICAD	NBC OC	Inform NBC analyst and all Task Force OCs of reports sent.								F				M	F
116	BIDS, MICAD	TF OCs	Determine if NBC report received by player counterpart.								F				F	M
117	BIDS, MICAD	TF OCs	Announce findings on control net								F				M	F
118	BIDS, MICAD	TF OCs	Inform NBC analyst of number of WIA and KIA.	M			M	M	M						M	
119	BIDS, MICAD	NBC Analyst	Record number of WIA and KIA reported by OCs.	M			M	M	M					P		M
120	NBC Systems	OC	Initiate indication of a chemical or biological attack				M	M	M							
121	NBC Systems	OC	Assess hasty decontamination procedures.									P				
122	NBC Systems	OC	Determine if deliberate decon requested								F				F	
123	NBC Systems	OC	Inform TAF analyst of planned or directed route to deliberate decon site.								P				M	P
124	NBC Systems	OC	Inform TAF analyst of deliberate decon location.								F				M	F
125	NBC Systems	OC	Assess completeness of equipment and supplies at decon site.									F				

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
126	NBC Systems	OC	Assess deliberate decon procedures performed.									P				
127	NBC Systems	OC	Assess casualties as appropriate.									F			P	
128	NBC Systems	OC	Inform NBC analyst of all assessments.									F			M	
129	NBC Systems	NBC Analyst	Plot planned/directed and actual route to deliberate decontamination site.								M			P		F
130	NBC Systems	NBC Analyst	Plot location of deliberate decontamination site.								F					F
131	NBC Systems	NBC Analyst	Record OC assessment of decontamination equipment and supplies, decontamination procedures, and casualties.									M				M
132	Acoustic Beam Weapon	OC	Determine weapon intensity settings.					F	F			F				
133	Acoustic Beam Weapon	OC	Determine area affected by weapon and inform TAF analyst	M			M	F	F	F					P	
134	Acoustic Beam Weapon	OC	Identify affected antagonists.	M			M	F	F	F					P	
135	Acoustic Beam Weapon	OC	Assess degree of degradation: Provide NEAR MISS for MILD IRRITANT, provide MULTIPLE NEAR MISSES for SEVERE IRRITANT, KILL then later RESURRECT for DEBILITATING EFFECTS, KILL for WIAs.							F						
136	Acoustic Beam Weapon, Bean Bag Round	OC	Determine shooter ID.	M			M	F	F			F			P	
137	Acoustic Beam Weapon	OC	Identify victim ID and degree of degradation: Mild irritation, severe irritation, debilitating injury, WIA.							F					P	

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138	Acoustic Beam Weapon, Casualty Evacuation	TAF Analyst	Record shooter ID, affected area, casualty information, and observations from OC.	P			P	M	M	M		P		P		M
139	Aqueous Foam Barrier	OC	Assess victim degree of degradation: Provide victims a NEAR MISS indication for IRRITANT warning, Execute control gun KILL for WIAs					P	P	F						
140	Aqueous Foam Barrier	OC	Resurrect WIAs as required based on self-aid and buddy-aid.									M				
141	Aqueous Foam Barrier	OC	Determine shooter ID, victim and shooter location, barrier agent type, location (XYZ), dimensions, and orientation					M	M	P	P	F				
142	Aqueous Foam Barrier	OC	Determine the location of breach/lane												P	
143	Aqueous Foam Barrier	OC	Record type wounds from non-lethal casualty cards and inform TAF analyst.												P	
144	Aqueous Foam Barrier	TAF Analyst	Record shooter and victim ID, shooter and victim location, barrier agent type, location, XYZ dimensions, and orientation from OC.					M	M	P	P	F		P		M
145	Aqueous Foam Barrier	TAF Analyst	Plot barrier in workstation display.						F		M	F				M
146	Aqueous Foam Barrier	TAF Analyst	Record and plot breach/lane into workstation display.						P							M
147	Bean Bag Round, LWS, Electric Water Cannon	OC	Assess casualties for close-in engagements (less than 10 meters).					F	F							

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148	Bean Bag Round, Aqueous Foam Barrier, LWS, Electric Water Cannon	OC	Assess casualties for inoperative MILES					F	F				F			
149	Bean Bag Round, LWS, Electric Water Cannon	OC	Assess casualties for MILES limitations: "MILES berms," "Leaf defilade," "Canvas defilade"					F	F							
150	Bean Bag Round, Aqueous Foam Barrier, LWS, Electric Water Cannon	OC	Assess casualties for rules of engagement (ROE) violations					F	F				M			
151	Bean Bag Round, Electric Water Cannon	OC	Record shooter and victim ID for control gun assessments							P		P			P	
152	Bean Bag Round, LWS, Electric Water Cannon	OC	Record type wounds for WIA assessment												P	
153	LWS, Bean Bag Round, Electric Water Cannon	TAF Analyst	Record casualties for close-in engagements (less than 10 meters)					F	F							M

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154	Bean Bag Round, Aqueous Foam Barrier, LWS, Electric Water Cannon	OC	Record casualties for inoperative MILES					F	F				F		P	
155	Bean Bag Round, LWS, Electric Water Cannon	OC	Record casualties for MILES limitations (MILES berms, leaf defilade, canvas defilade)					F	F						P	
156	Bean Bag Round, Aqueous Foam Barrier, LWS, Electric Water Cannon	OC	Record casualties for rules of engagement (ROE) violations					F	F				M		P	
157	Bean Bag Round, LWS, Electric Water Cannon	TAF Analyst	Record manual and instrumented battle casualty assessments received from OC					P	P				P			M
158	Bayonet	OC	Coordinate with attacking soldier to determine victim identification													
159	Bayonet	OC	Verify soldier has proper weapon available for silent kill													
160	Bayonet	OC	Assess realistic ability for silent attack based on soldier and victim location													
161	Bayonet	OC	If procedures for attack valid, physically wake up, or if awake, notify victim they are KIA and why, key their MILES harness, and replace their casualty card with a KIA card													

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162	Bayonet	OC	Record attacker and victim ID and location												M	
163	Bayonet	OC	Monitor unit actions in determining status of soldiers													
164	Bayonet	OC	Monitor unit actions in replacement of KIAs													
165	Bayonet	OC	Record attacker and victim status												M	
166	Bayonet	OC	Record weapon type used												M	
167	Bayonet	OC	Inform MVR TAF analyst of engagement results												M	
168	Bayonet	OC	Record and evaluate unit actions taken to replace KIA soldier												M	
169	Bayonet	MVR TAF Analyst	Record silent kill engagement results from OC													P
170	Casualty Evacuation	Unit OC	Identify KIAs and WIAs.	P			P	P	P	P					P	
171	Casualty Evacuation	Unit OC	Observe casualty evacuation and treatment.									F				
172	Casualty Evacuation	Unit OC, Bn Aid Station OC	Resurrect players as appropriate.									F				
173	Casualty Evacuation	Unit OC, Bn Aid Station OC	Assess WIAs as died of wounds (DOWs) as appropriate.									F				
174	Casualty Evacuation	Unit OC	Report KIAs, WIAs, and DOWs to TAF analyst.	P			P	P	P	P	P	M			P	
175	Casualty Evacuation	Bn Aid Station OC	Observe treatment and evacuation of WIAs.									F			P	

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176	Casualty Evacuation	Bn Aid Station OC	Report WIAs status and DOWs to TAF analyst.									F			P	
177	Casualty Evacuation	S1 OC	Reconcile KIA/WIA reports with other OCs.	P			P	P	P		P	P			M	P
178	Casualty Evacuation	S1 OC	Monitor and assess personnel replacement procedures.								P	F			P	
179	Casualty Evacuation	TAF Analyst	Record casualty information and observations from OC.								P	F				M
180	Casualty Evacuation	TAF Analyst	Record KIAs, WIAs, and DOWs as reported by OCs.								P	F				M
181	Casualty Evacuation	TAF Analyst	Record OC assessments of medical treatment and personnel replacement procedures.													M
182	Battle Damage Repair	OC	Determine when BLUFOR has adequate maintenance personnel on site to effect repairs.									F				
183	Battle Damage Repair	OC	Determine when BLUFOR has adequate repair parts on site to effect repairs.								P	F				
184	Battle Damage Repair	OC	Determine time required to complete repair actions.									F			P	
185	Battle Damage Repair	OC	Resurrect BLUFOR vehicles after repair actions completed.									F				
186	Battle Damage Repair	TAF Analyst	Record equipment battle damage assessments and OC observations.								P	M				P

RSTA

1	FireFinder	TAF Analyst	Record and process requested OPFOR artillery and mortar fire missions.						M							M

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2	FireFinder	TAF Analyst	Pass the firing unit ID, unit location, and impact location to the RSS operator to process for acquisition by BLUFOR FireFinder radars.						F							M
3	FireFinder	TAF Analyst	Record OPFOR firing unit ID, unit location, and impact location received from another FS TF Analyst.						F							M
4	FireFinder	TAF Analyst	FS TAF Analyst enters OPFOR fire mission into SAWE control station and passes shooter ID, shooter location and target location to RSS operator.						F							M
5	FireFinder	TAF Analyst	Enter shooter ID, shooter location, and target location into RSS.						F							
6	FireFinder	TAF Analyst	Record time trajectory sent to FireFinder radar.						F							
7	FireFinder	TAF Analyst	Record radar call for fire provided by FDC OC.								F					M
8	FireFinder	OC	Notify FS TAF Analyst (RSS operator) of all counter battery/counter mortar calls for fire from FireFinder radars.								F				P	
9	Ground Surveillance Radars (GSR), MTI Radar, REMBASS	OC	Obtain the following targeting data from the GSR: Time target detected, Target location, Target type, Target direction, Target speed, System ID, System location.								M	P				
10	GSR, MTI Radar	TAF Analyst	Plot actual system search sector.													P
11	GSR, MTI Radar, REMBASS	TAF Analyst	Record and report actual OPFOR activities within system search sectors to TF S2 OC.												F	M

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12	GSR, MTI Radar, REMBASS	TAF Analyst	Record the following information from the TF S2 OC: Target Location, type, direction, and speed; Detecting system ID; System location.								M	P				M
13	Bird Dog, Maneuver UAV	OC	Provide aircraft and UAV planned and revised flight routes, search areas, and search criteria to AVN TAF Analyst.								M				M	
14	Bird Dog	OC	Note player response to acquired targets and target locations and inform AVN TAF Analyst.												P	
15	Bird Dog, Maneuver UAV	TAF Analyst	Plot aircraft and UAV planned and revised flight routes, search areas, and record search criteria.								M					P
16	Bird Dog, Maneuver UAV	TAF Analyst	Record UAV acquired targets and target locations								M					M
17	Bird Dog	TAF Analyst	Record player response to reports of acquired targets and target locations.													M
18	Hunter Sensor Suite, LRAS3	OC	Record search areas and search criteria for each sensor and forward to S2 TAF Analyst.								P				M	
19	Hunter Sensor Suite, LRAS3	OC	Record and report revisions to search areas and search criteria to S2 TAF Analyst.								P				M	
20	Hunter Sensor Suite, LRAS3, Maneuver UAV	OC	Record and report acquired targets and target locations to S2 TAF Analyst.								P				M	
21	Hunter Sensor Suite, LRAS3	TAF Analyst	Plot individual system planned and revised search areas.								P					P
22	Hunter Sensor Suite, LRAS3	TAF Analyst	Record system acquired targets and target locations.								P					M

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23	FAAD Ground Based Sensor	OC	Monitor air warning transmissions.								F				F	
24	FAAD Ground Based Sensor	TAF Analyst	Monitor air warning transmissions.								F					F
25	REMBASS	OC	Obtain planned sensor locations and pass to TAF analyst.								P				M	
26	REMBASS	OC	Obtain actual sensor locations and pass to TAF analyst.								P	F				
27	REMBASS	TAF Analyst	Plot planned sensor locations and area of coverage.													M
28	REMBASS	TAF Analyst	Plot actual sensor locations and area of coverage.									F				M
			C4I													
1	AFATDS	TAF Analyst	Crosswalk the fire support and field artillery support plans with the execution of fires.								P					P
2	AFATDS, ASAS, FBCB2, MCS	TAF Analyst	Transfer required digital information from the system into the instrumented workstation.													F
3	AFATDS, ASAS, FBCB2, MCS	TAF Analyst	Record player access to external information sources.								P					P
4	AFATDS	TAF Analyst	Crosswalk the mission value criteria with the targets attacked and the results (BDA).	P			P	P	P		P					P
5	AFATDS	TAF Analyst	Record potential targets vs. attacked targets.								P					F
6	AFATDS, ASAS, FBCB2, MCS	TAF Analyst	Annotate discrepancies between "ground truth" and "perceived truth," and their effects.								P					F

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7	AFATDS	OC	Observe and assess course of action development, selection, and the fire planning process.												P	P
8	AFATDS	OC	Observe fire mission processing.												P	
9	AFATDS, FBCB2	OC	Observe staff procedures and information accessed.												P	
10	AFATDS, ASAS	OC	Inform TAF analyst of all observations.												M	
11	AFATDS	OC	Crosswalk commander's intent into AFATDS targeting guidance.								M				P	P
12	AFATDS	OC	Inform TAF analyst of voice calls for fire.												M	
13	AFATDS	OC	Inform TAF analyst of message to observer.	F	P		F	F	F		M				F	M
14	AFATDS	OC	Inform TAF analyst when mission fired and any FDC or gun errors	F	P		F	F	F		P				P	P
15	ASAS	TAF Analyst	Crosswalk the mission information requirements to the information "pulled" by players and "pushed" by higher													P
16	ASAS	OC	Observe and assess staff procedures, war gaming, and IPB process.												P	
17	ASAS	OC	Observe and assess course of action development and selection and intelligence processing procedures.												P	
18	FBCB2, MCS	TAF Analyst	Crosswalk the mission information requirements to the information accessed by players.													P
19	FBCB2	OC	Observe and assess orders briefbacks, mission rehearsals, and mission execution.													
20	FBCB2	OC	Identify information sources accessed.								P				P	P

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21	MCS	OC	Observe and assess staff appraisals, briefbacks, and rehearsals.													
22	FAADS C2	TAF Analyst	Crosswalk the air defense plans with the maneuver commander's scheme of maneuver and execution.								M					P
23	FAADS C2	TAF Analyst	Transfer required digital information from the FAADS C2 into the instrumented workstation.								F					F
24	FAADS C2	TAF Analyst	Record potential targets, attacked targets, and fratricide incidents.								M					F
25	FAADS C2	TAF Analyst	Identify discrepancies between "ground truth" and "perceived truth" and their effects.								M					M
26	FAADS C2	OC	Observe targeting processing.												P	
27	FAADS C2	OC	Observe staff procedures and interactions (i.e., ADA commander and brigade S2).													
28	FAADS C2	OC	Inform TAF analyst of all observations.												M	
29	FAADS C2	OC	Crosswalk commander's intent into FAADS C2 targeting guidance and air defense plan.								M				P	P
30	FAADS C2	OC	Inform TAF analyst of voice air warnings.												M	
31	FAADS C2	OC	Inform TAF analyst when an air target is attacked and include information about firing unit or processing errors.					F	F		P				P	P
32	CSSCS	TAF Analyst	Crosswalk the logistics plans and OPORDs with the execution of CSS operations.								P					P

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33	CSSCS	TAF Analyst	Transfer required digital information from the CSSCS into the instrumented workstation.													F
34	CSSCS	TAF Analyst	Record player access to external information sources.								P					P
35	CSSCS	TAF Analyst	Coordinate with OC and record CSS "ground truth" information.													P
36	CSSCS	OC	Observe and record "ground truth" status and procedures for CSS information.												P	
37	CSSCS	OC	Observe and record voice requests for CSS related issues.												P	
38	CSSCS	OC	Observe CSS course of action development and selection.												P	
39	CSSCS	OC	Crosswalk logistics plan with the actual execution of CSS operations.								P				P	
40	CSSCS	OC	Inform TAF analyst of all observations.												M	

OC Coordination and Mentoring Tasks

1	OC Control	OC	Develop observation and control plan to preclude overlooked or uncontrolled events.												P	
2	OC Control	OC	Perform risk assessment and cross-check assess with BLUFOR counterpart.												P	
3	OC Control	OC	Check vehicle TES for proper operation.										F			
4	OC Control	OC	Assist unit in diagnosing and correcting TES problems.										M			
5	OC Control	OC	Coordinate with MILES contact team for repair of player MILES equipment.					F	F				F		P	
6	OC Control	OC	Resurrect dead players.										P			

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7	OC Control	OC	Provide and receive observations from other OCs and the TAF.												M	
8	OC Control	OC	Coordinate with OCs and TAF analysts to assess non-MILES engagements and rules of engagement violations.	P			P	M	M				P		M	
9	OC Control	OC	Coordinate with OPFOR on planned actions, obstacles, and attacks against BLUFOR TOCs, unit trains, and staging areas.												M	
10	OC Control	OC	Coordinate and assist linkup and pickup of abandoned enemy prisoners of war (EPWs) and OPFOR and BLUFOR WIAs and KIAs.												M	
11	OC Control	OC	Submit pre-formatted reports to TAF counterpart and senior OC.												M	
12	OC Control	OC	Make detailed observation notes.												M	
13	OC Control	OC	Keep an accurate timeline of all unit actions.								P	P			P	M
14	OC Control	OC	Investigate and report how and why fratricides occurred.												P	
15	OC Control	OC	Link observations to key issues (teaching points.)												P	
16	OC Control	OC	Identify key issues which most affected battle outcome.												P	
17	OC Control	OC	Coordinate key issues with OPFOR to ensure consistency during AAR.												P	
18	OC Control	OC	Link key issues to exercise objectives and military doctrine.												P	
19	OC Control	OC	Coordinate with TAF analyst on AAR products.												M	
20	OC Control	OC	Rehearse and conduct AAR.												P	

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21	OC Control	OC	Provide one-on-one coaching to BLUFOR counterpart during exercise pauses.												P	
22	OC Control	OC	Submit performance summaries for unit THP.												M	
			AAR Aid Construction													
1	Intelligence BOS	OC	Identify specific areas of unit tactical weakness.												P	
2	Intelligence BOS	OC	Inform TAF analyst.												M	
3	Intelligence BOS	OC	Provide guidance to TAF analyst for specific areas of interest for AAR.												M	
4	Intelligence BOS	TAF Analyst	Record specific areas of unit tactical weakness.													M
5	Intelligence BOS	TAF Analyst	Record guidance from OC on specific areas of interest for AAR.													M
6	Intelligence BOS	TAF Analyst	Obtain MTP (electronic).											M		F
7	Intelligence BOS	TAF Analyst	Identify tasks related to OC's evaluations.											M		M
8	Intelligence BOS	TAF Analyst	Enter standards and procedures from appropriate tasks in the MTP.											F		M
9	Intelligence BOS	TAF Analyst	Type in Aid title.													P
10	Intelligence BOS	OC	Obtain all overlays and transport to TAF.								F				F	F
11	Intelligence BOS	TAF Analyst	Obtain copy of TF OPORD and type TF mission.								M					P
12	Intelligence BOS	TAF Analyst	Pan to geographic area of the operation.													M

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13	Intelligence BOS	TAF Analyst	Obtain and trace or scan in all overlays.								F					M
14	Intelligence BOS	TAF Analyst	Obtain Intelligence Annex and plot enemy avenues of approach.								M					M
15	Intelligence BOS	TAF Analyst	Review R&S plan and plot and label all NAIs.								P					M
16	Intelligence BOS	TAF Analyst	Enable maneuver and R&S overlays.													M
17	Intelligence BOS	TAF Analyst	Time tag top-down view to create Snapshot AAR aid.													M
18	Intelligence BOS	OC	Inspect and report actual sensor locations to TAF analyst.												P	
19	Intelligence BOS	TAF Analyst	Plot and label actual sensor locations provided by OC.											P		M
20	Intelligence BOS	TAF Analyst	Develop and enter open-ended questions to support AAR discussion.											M		P
21	Intelligence BOS	TAF Analyst	Enable electronic line of sight profiles from GSR location.													M
22	Intelligence BOS	TAF Analyst	Construct electronic line of sight profile from alternative GSR location.											P		M
23	Intelligence BOS	TAF Analyst	Consult appropriate reference materials.											M		M
24	Intelligence BOS	TAF Analyst	Enter appropriate improvement tips.											M		P
25	CSS BOS	TAF Analyst	Enter narrative of the tactical situation.													P
26	CSS BOS	TAF Analyst	Enable maneuver and target overlays.													M
27	CSS BOS	OC	Collect WIA and KIA data based on MILES casualty cards.	P			P	F	F						P	

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28	CSS BOS	OC	Collect DOW data based on OC CASEVAC assessments.									F			P	
29	CSS BOS	OC	Provide KIA, WIA, and DOW data to TAF analyst.	P			P	M	M		P	P			M	
30	CSS BOS	TAF Analyst	Enter KIA, WIA, and DOW information into database.	P			P	M	M		P	P		P		M
31	CSS BOS	TAF Analyst	Select Casualty Summary report from the database to create AAR aid.											F		F
32	CSS BOS	TAF Analyst	Select DOW Casualty Summary report from the database to create AAR aid.											F		F
33	MCM BOS	TAF Analyst	Enable maneuver, target, and obstacle overlays.													M
34	MCM BOS	OC	Identify time for TAF analyst to time tag Snapshot AAR aid.												M	
35	MCM BOS	OC	Identify start and end times for TAF analyst to time tag Plan View AAR aid.												M	
36	MCM BOS	TAF Analyst	Time tag start and end times of top-down view to create Plan View AAR aid.											M		M
37	MCM BOS	TAF Analyst	Time tag any applicable audio for playback.											M		M
38	MCM BOS	TAF Analyst	Direct video crew to site to capture video of suppression, smoke, and breaching activities.													M
39	MCM BOS	TAF Analyst	Time tag any applicable video for playback.											M		M
40	MCM BOS	TAF Analyst	Identify start and end times for breaching operation.													M

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
41	MCM BOS	TAF Analyst	Examine instrumentation data and determine total number of BLUFOR and OPFOR direct fire rounds fired between start and end times of the breaching operation.											F		F
42	MCM BOS	TAF Analyst	Examine instrumentation data and determine total number of BLUFOR and OPFOR indirect fire rounds fired between start and end times of the breaching operation.											F		F
43	MCM BOS	TAF Analyst	Enter data into database.											F		F
44	MCM BOS	TAF Analyst	Prepare graphical representation depicting number of BLUFOR direct fire rounds fired each minute from beginning to end of the breaching operation.											F		F
45	MCM BOS	TAF Analyst	Prepare graphical representation depicting number of BLUFOR indirect fire rounds fired each minute from beginning to end of the breaching operation.											F		F
46	MCM BOS	TAF Analyst	Prepare graphical representation depicting number of OPFOR direct fire rounds fired each minute from beginning to end of the breaching operation.											F		F
47	MCM BOS	TAF Analyst	Prepare graphical representation depicting number of OPFOR indirect fire rounds fired each minute from beginning to end of the breaching operation.											F		F
48	MCM BOS	TAF Analyst	Create a legend for aid.											F		F

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
49	MCM BOS	OC	Collect Battle Damage Assessment (BDA)	P			P	F	F			P			P	
50	MCM BOS	OC	Provide BDA data to TAF analyst.	P			P	F	F			P			M	
51	MCM BOS	TAF Analyst	Enter BDA information into database.	P			P	F	F			P		M		M
52	MCM BOS	TAF Analyst	Select BLUFOR/OPFOR Loss report from the database to create "BLUFOR/OPFOR Losses" table.											F		M
53	MCM BOS	TAF Analyst	Create "Forces Remaining" table with number and percentage of remaining BLUFOR and OPFOR combat vehicles.											F		F
54	MCM BOS	TAF Analyst	Show a successful execution from a previous rotation ("A Way").											M		M
55	MCM BOS	TAF Analyst	In lieu of providing "A Way" from a previous rotation, create necessary CGF scenario to replicate OPFOR and BLUFOR forces and position BLUFOR as appropriate to show alternative solution.						M							
56	MCM BOS	TAF Analyst	Activate CGF scenario to demonstrate an animated view of an alternative solution.						M							
57	FS BOS	TAF Analyst	Enable target overlay.													M
58	FS BOS	TAF Analyst	Label speed determined and formula to compute trigger point distance on slide at appropriate location.													P
59	FS BOS	TAF Analyst	Label formula to compute trigger point distance with sample values to determine "how" to compute distance to trigger point.													P

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
60	FS BOS	TAF Analyst	Label trigger point at appropriate location on overlay.													P
61	MVR BOS	OC	Record operational vehicles by type at STARTEX.								F				P	
62	MVR BOS	OC	Record battle damage for vehicles by type at ENDEX.	P			P	F	F					M	P	
63	MVR BOS	OC	Provide STARTEX operational and ENDEX BDA totals to MVR TAF analyst.	P			P	M	M		M			M	M	
64	MVR BOS	TAF Analyst	Coordinate with OC for number of BLUFOR operational vehicles by type at STARTEX and battle damage assessment at ENDEX.	P			P	M	M		M			M		P
65	MVR BOS	TAF Analyst	Coordinate with OC for number of OPFOR operational vehicles by type at STARTEX and battle damage assessment at ENDEX.	P			P	M	M					M		P
66	MVR BOS	TAF Analyst	Calculate battle loss percentages for OPFOR and BLUFOR.								P			F		F
67	MVR BOS	TAF Analyst	Construct Graph aid.											F		F
68	MVR BOS	TAF Analyst	Examine instrumentation data and determine total number of direct fire rounds fired by type.									F		M		M
69	MVR BOS	TAF Analyst	Examine instrumentation data and determine impact location for all direct fire rounds fired by type.			F								M		M
70	MVR BOS	TAF Analyst	Prepare graphical representation grouping the distribution of impacting ordnance.											F		F

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
71	MVR BOS	TAF Analyst	Calculate percentage of total direct fire rounds fired into each group and label each group with percentage.											F		F
72	MVR BOS	TAF Analyst	Identify killed vehicles engaged with additional rounds and label each killed vehicle with the number of subsequent rounds received.											F		F
73	MVR BOS	TAF Analyst	Examine instrumentation data and determine total number of indirect rounds fired by type.									F		F		F
74	MVR BOS	TAF Analyst	Examine instrumentation data and determine impact location for all indirect fire rounds by type.			F								F		F
75	MVR BOS	TAF Analyst	Prepare graphical representation grouping the distribution of impacting lethal ordnance.											F		F
76	MVR BOS	TAF Analyst	Calculate percentage of total indirect fire rounds fired into each group and label each group with percentage.									P		F		F
77	MVR BOS	TAF Analyst	Determine impact location of smoke.			F						P		F		F
78	MVR BOS	TAF Analyst	Obtain weather data and calculate area affected by smoke.					F	F		P			F		F
79	MVR BOS	TAF Analyst	Identify and obtain all appropriate video segments.											P		M
80	MVR BOS	TAF Analyst	Edit video for reinforcement of desired teaching points.											P		M
81	MVR BOS	TAF Analyst	Coordinated with video section to present video at AAR.											P		M

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
82	MVR BOS	TAF Analyst	Identify and obtain all appropriate audio segments for reinforcement of desired teaching points.											M		M
83	MVR BOS	TAF Analyst	Determine number of direct fire rounds fired each minute for the time span from the initiation to cessation of suppressive fires.									M		F		M
84	MVR BOS	TAF Analyst	Determine number of indirect fire rounds fired each minute for the time span from the initiation to cessation of suppressive fires.									M		F		M
85	MVR BOS	TAF Analyst	Determine number of smoke rounds fired each minute for the time span from the initiation to cessation of suppressive fires.									M		F		M
86	MVR BOS	TAF Analyst	Determine number of assault force vehicles killed each minute for the time span from the initiation to cessation of suppressive fires.	P			P	F	F					M		M
87	MVR BOS	TAF Analyst	Identify time assault elements initiated the assault.											F		M
88	ADA BOS	TAF Analyst	Prepare Snapshot AAR aid of each section's occupation and emplacement.											M		P
89	ADA BOS	TAF Analyst	Create Snapshot AAR aid providing the correct ADA coverage as an alternative solution.											M		P
90	C2 BOS	OC	Record time and Order Number and type received from the player unit's logs.								F				F	M
91	C2 BOS	OC	Record observations of unit receipt of orders.												F	

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
92	C2 BOS	OC	Forward logs or recorded information to the TAF analyst.												F	
93	C2 BOS	TAF Analyst	Record information from OC.													M
94	C2 BOS	TAF Analyst	Create time-line graphic and plot each unit's time of receipt.											F		M
95	C2 BOS	TAF Analyst	Retrieve chart containing historical "text-book" solution.											F		M
96	C2 BOS	TAF Analyst	Edit chart with any unit specific information.											P		M
97	ALL BOS	TAF Analyst	Review all created aids and select appropriate aids for AAR.											M		M
98	ALL BOS	OC	Review all created aids and select appropriate aids for AAR.											M	M	M

Take Home Package (THP)

1	THP	SR OC	Type and print rotation executive summary.												P	
2	THP	SR OC	Type and print battle summary for each mission.												P	
3	THP	SR OC, BOS OC, CO OC	Pass summaries to TAF analyst for inclusion into THP.												P	
4	THP	BOS OC	Type and print BOS summaries by mission.												P	
5	THP	CO OC	Type and print Co/Tm summaries by mission.												P	
6	THP	OC	Investigate and document all fratricides.	P			P	P	P					P	P	
7	THP	OC	Pass results of fratricide investigation to the TAF analyst.	P			P	P	P						M	
8	THP	TAF Analyst	Print selected AAR aids for each mission.											P		M

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
9	THP	TAF Analyst	Assemble all OC summaries and selected AAR aids.													
10	THP	TAF Analyst	Create table of contents for written report.													**P**
11	THP	TAF Analyst	Reproduce copies of written report.													**M**
12	THP	TAF Analyst	Coordinate with audio visual facility for copies of AAR video tapes.													
			DTOC													
1	AFATDS, ASAS, FBCB2, MCS	DTOC Controller	Role play higher, supporting, and adjacent units.													
2	AFATDS, ASAS, FBCB2, MCS	DTOC Controller	Send, receive, and action voice and digital communications													
3	AFATDS, ASAS, FBCB2, MCS	DTOC Controller	Send, receive, and action overlays/graphics.													
4	AFATDS, ASAS, FBCB2, MCS	DTOC Controller	Send, receive, and action requests.													
5	AFATDS, ASAS, FBCB2, MCS	DTOC Controller	Send, receive, and action reports.													
6	AFATDS, ASAS, FBCB2, MCS	DTOC Controller	Send, receive, and action free text messages.													
7	AFATDS, ASAS, FBCB2	DTOC Controller	Send, receive, and action enemy situation updates.													
8	AFATDS, ASAS	DTOC Controller	Process and provide targeting data.													

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
9	AFATDS	DTOC Controller	Process and provide commanding general's (CG) intent													
10	AFATDS	DTOC Controller	Process and provide connections to other sensors, collection systems, and information													
11	AFATDS	DTOC Controller	Process and provide field artillery guidance.													
12	AFATDS	DTOC Controller	Process and provide divisional field artillery support plan.													
13	AFATDS	DTOC Controller	Process and provide counterfire support													
14	AFATDS	DTOC Controller	Process and provide deep attack operations and targets.													
15	AFATDS	DTOC Controller	Translate CG's intent into AFATDS entries.													
16	AFATDS	DTOC Controller	Manage and ensure flow of targeting, fire mission information, and intelligence.													
17	AFATDS	DTOC Controller	Coordinate clearance for fires across fire support coordination measures.													
18	ASAS, MCS	DTOC Controller	Send, receive, process, and provide warnings.													
19	ASAS	DTOC Controller	Send, receive, process, and provide electronic warfare support.													
20	ASAS	DTOC Controller	Send, receive, process, and provide collection assets.													
21	ASAS	DTOC Controller	Send, receive, process, and provide intelligence analysis.													
22	ASAS	DTOC Controller	Send, receive, process, and provide situational analysis.													

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
23	ASAS	DTOC Controller	Provide connections to other sensors and collection systems.													
24	FBCB2, MCS	DTOC Controller	Send, receive, and action warning orders.													
25	FBCB2, MCS	DTOC Controller	Send, receive, and action OPORDs.													
26	FBCB2, MCS	DTOC Controller	Send, receive, and action FRAGOs.													
27	FBCB2	DTOC Controller	Send, receive, and action calls for fire.													
28	FBCB2	DTOC Controller	Send, receive, and action resupply points.													
29	FBCB2	DTOC Controller	Send, receive, and action air tracks and warnings.													
30	MCS	DTOC Controller	Send, receive, and action telestration.													
31	MCS	DTOC Controller	Send, receive, and action unit task organizations.													
32	MCS	DTOC Controller	Provide connection to notional player informational resources division and higher, as requested.													
33	FAADS C2	DTOC Controller	Translate CG's intent into ADA Plan (i.e. assigned air avenues of approach and NAIs).													
34	FAADS C2	DTOC Controller	Process and provide target attack guidance.													
35	FAADS C2	DTOC Controller	Process and provide intelligence information.													
36	FAADS C2	DTOC Controller	Process and provide air warnings from deep attack operations.													

	System	Trainer	OC and TAF Analyst Control & Data Collection Tasks	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
37	FAADS C2	DTOC Controller	Process and provides higher ADA and protection plan.													

F - Fully Automates Task M - Automates Majority of Task P - Automates Some Aspects of Task

APPENDIX L -- CROSSWALK OF STRATEGIES TO TES/IS LIMITATIONS

This appendix crosswalks strategies in the basic report with all TES/IS limitations (N-coded items) identified in the study. Our analysis of intrinsic and extrinsic feedback requirements for force modernization initiatives identified 78 TES/IS limitations.

The spreadsheet contained in this appendix shows the impact of the study's 13 strategies in reducing the TES/IS limitations using the following legend:

F--Limitations fully eliminated by a strategy or combination of strategies

M--Limitations in which a strategy or combination of strategies eliminates the majority of the limitation

P--Limitations in which a strategy or combination of strategies eliminates some aspects of the limitation

The spreadsheet is sub-divided into categories--weapons, RSTA, and C4I.

Appendix L -- Crosswalk of Strategies to TES and IS Limitations

	System	Feedback Type	TES and IS Limitation	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
			WEAPONS													
1	Abrams	Intrinsic	Pairing of shooter to MISSES					F	F							
2	Abrams, STAFF Round, OICW, Bean Bag Round, AH64 Hellfire, Longbow Hellfire	Extrinsic	Pairing of shooter to MISSES			F		F	F							
3	Abrams, STAFF Round, OICW, Bean Bag Round, AH64 Hellfire, Longbow Hellfire	Extrinsic	Ammunition type and amount on hand					M	M			F		P		P
4	Abrams, STAFF Round, OICW, Bean Bag Round, AH64 Hellfire, Longbow Hellfire	Extrinsic	Ammunition type fired and amount					M	M			F		P		P
5	Abrams, STAFF Round	Extrinsic	Turret Orientation					F	F					M		M
6	STAFF Round	Intrinsic	Visual/audible indication of ordnance effects: Fully operational, catastrophic kill, mobility kill, firepower kill, communications kill, type combat damage					F	F							

	System	Feedback Type	TES and IS Limitation	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
7	STAFF Round, OICW	Intrinsic	Out of action for MILES engagements					F	F				F			
8	STAFF Round, OICW	Intrinsic	Out of action for control gun assessments					F	F							
9	STAFF Round, LWS, OCSW, Bean Bag Round, Crusader	Intrinsic	Visual/audible indication of impacting ordnance (direct hits only)				M	F	F							
10	STAFF Round, Longbow Hellfire, Javelin	Intrinsic	Location of ordnance MISSES					P	P							
11	STAFF Round, OICW	Extrinsic	Victim ID					F	F							
12	STAFF Round, OICW	Extrinsic	Victim location					F	F							
13	STAFF Round	Extrinsic	Victim Status: Fully operational, catastrophic kill, mobility kill, firepower kill, communications kill, type combat damage					F	F							M
14	STAFF Round, OICW	Extrinsic	Shooter ID					F	F			F				
15	STAFF Round, OICW	Extrinsic	Shooter location					F	F			F				
16	STAFF Round	Extrinsic	Time mission fired									F				

	System	Feedback Type	TES and IS Limitation	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
17	STAFF Round, Bean Bag Round, AH64 Hellfire, Longbow Hellfire, Avenger, M56, Multispectral Obscurant	Extrinsic	Location of shooter and victim when intervisible and exposure time													M
18	STAFF Round, OICW	Extrinsic	Pairing of shooter to victim	M			M	M	M			P				
19	STAFF Round, OICW	Extrinsic	Shooter ranging capability													M
20	LWS, OICW, Bean Bag Round, AH64 Hellfire, Longbow Hellfire	Intrinsic	Location of impacting ordnance (other than direct hits)					F	F							
21	LWS	Intrinsic	Visual/audible indication of ordnance effects: Firepower kill, C4I kill													
22	LWS	Extrinsic	Victim status: Firepower kill, C4I kill					F	F							F
23	LWS, OCSW, AH64 Hellfire, Avenger	Extrinsic	Hit/Kill aspect angle					F	F							
24	OICW	Intrinsic	Visual/audible indication of ordnance effects: Combat Effective, Out of action, WIA (type wounds), KIA, Firepower kill, C4I kill													
25	OICW	Extrinsic	Victim status: Combat effective, out of action, WIA (Type wounds), KIA					F	F							M

	System	Feedback Type	TES and IS Limitation	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
26	Bean Bag Round	Intrinsic	Visual/audible indication of ordnance effects: Type ordnance fired, Visual indication of impacting ordnance other than direct hits						F							
27	Bean Bag Round	Intrinsic	Visual indication of impacting ordnance other than direct hits						F							
28	AH64 Hellfire, Longbow Hellfire, Avenger	Intrinsic	Missile trajectory					F	F							
29	AH64 Hellfire, Longbow Hellfire	Intrinsic	Audible signature when weapon fires					F	F							
30	Longbow Hellfire, Avenger	Extrinsic	Missile trajectory					F	F					F		
31	Avenger	Extrinsic	Pairing of shooter to missile trajectory					F	F					F		
32	EFOG-M	Intrinsic	Visual/audible signature when weapon fires					F	F							
33	EFOG-M	Intrinsic	Needs to "fly" weapon to target and "see" terrain under weapon to navigate on preplanned route and hit target					F	F							
34	EFOG-M	Extrinsic	Actual flight route					F	F							
35	EFOG-M	Extrinsic	Pairing of shooter to location of ordnance impact MISSES			F										
36	M56, Multispectral Obscurant	Intrinsic	Visual indication of obscurant type: Thermal obscurant, Millimeter wave obscurant													
37	M56, Multispectral Obscurant	Extrinsic	Geographical area affected					P	P					P		P

	System	Feedback Type	TES and IS Limitation	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
38	MICAD	Extrinsic	MICAD sensors location									F				
39	Intelligent Minefield	Intrinsic	Communication with mine sensors for: Mine detection of targets, command detonation													
40	Intelligent Minefield	Intrinsic	Communication for mine sensors to request reinforcing fires													
41	Intelligent Minefield	Extrinsic	Mines command detonated									F				
42	Intelligent Minefield	Extrinsic	Mines self-activated						F							
43	Intelligent Minefield	Extrinsic	Reinforcing fires requested by mines													
44	Volcano Mine System	Intrinsic	Visual indication of actual mine locations (Volcano dispersed)					F	F							
45	ORSMC	Intrinsic	Visual/audible signature of exploding smart mines (seismic, acoustic) from radiating signals				F	F	F							
46	Bayonet	Intrinsic	Execution of actual attack													
			RSTA													
1	GSR, MTI, Hunter Sensor Suite, LRAS3, REMBASS	Extrinsic	Player response to target acquisition													
2	Bird Dog UAV, Maneuver UAV	Intrinsic	Visual/audible indication of UAV status: Fully operational, catastrophic kill					F	F							
3	Bird Dog UAV, Maneuver UAV	Extrinsic	UAV ID													
4	Bird Dog UAV, Maneuver UAV	Extrinsic	UAV location					F	F							F

	System	Feedback Type	TES and IS Limitation	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
5	Bird Dog UAV, Hunter Sensor Suite, LRAS, Maneuver UAV	Extrinsic	Time tagged video display								M					
6	Bird Dog UAV, Maneuver UAV	Extrinsic	UAV status after OPFOR engagement: Fully operational, Catastrophic kill					F	F							
7	Bird Dog UAV, FAAD GBS	Extrinsic	Target type								F					
8	Bird Dog UAV, FAAD GBS	Extrinsic	Target location								F					
9	Bird Dog UAV	Extrinsic	Revised UAV flight plan								F					
10	LRAS3	Extrinsic	System search sector								F					
11	BCIS	Extrinsic	Results of IFF query													
12	BCIS	Extrinsic	Pairing of shooter to point of impacting ordnance (Misses)			F										
			C4I													
1	AFATDS, ASAS, FBCB2, MCS	Intrinsic	Notional player input to Force Level Information (FLI) database.													
2	AFATDS, ASAS, FBCB2, MCS	Intrinsic	Notional player common picture (entity level resolution).													
3	AFATDS	Extrinsic	Decision support tools used: Views of the terrain and situation; AFATDS recommendations and when intervention points were used or overridden.								P					
4	AFATDS	Extrinsic	Player actions and inactions on received information and reports.								P					P

	System	Feedback Type	TES and IS Limitation	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
5	AFATDS, ASAS	Extrinsic	System is not integrated with current instrumentation system for collection of digital data.								F					
6	ASAS	Extrinsic	Player actions and inactions on received information and predictions of enemy actions.								P					P
7	ASAS	Extrinsic	Decision support tools used: Views of the terrain; Integrated Weather Effects Data Analyzer (IWEDA); terrain enemy movement analyzer; sensor placement tools.								P					
8	FBCB2	Extrinsic	Decision support tools used: views of the terrain; weather reports; personnel and logistics status reports; intelligence reports								P					
9	FBCB2, MCS	Extrinsic	Player actions and inactions on received information								P					P
10	MCS	Extrinsic	Decision support tools used: terrain analysis tools; weather analysis; status reports.								P					
11	MCS	Extrinsic	Information sources accessed and player actions/inactions.								P					P
12	FAADS C2	Intrinsic	Decision support tools used: Views of sensor coverage or unit positioning.								P					
13	FAADS C2	Extrinsic	Firing unit actions and inactions on received information, reports, and warnings.								P					P
14	FAADS C2	Extrinsic	FAADS C2 is not integrated with current instrumentation system for collection of digital data.								F					

	System	Feedback Type	TES and IS Limitation	Automate NLOS BDA	Pair Designator to Target Designated	Pair Shooter to Misses	Reduce Pyrotechnics Expended for NLOS Battlefield Effects	Overcome Limitations of Laser Technology	Provide a Virtual OPFOR	Provide Tactile Feedback	Automate C4I Data Collection and Control Actions	Automate Tracking of Player Activities and Expended Resources	Automate TES System Monitoring	Automate AAR Preparation	Provide OC a Control, Observation, and FBCB2 Workstation	Upgrade TAF Analyst Workstation
15	CSSCS	Extrinsic	Decision support tools used: CSSCS recommendations/reports.								P					
16	CSSCS	Extrinsic	CSSCS is not integrated with current instrumentation system for collection of digital data.								F					

F - Fully Automates Task M - Automates Majority of Task P - Automates Some Aspects of Task